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Employment Protection Legislation in a Frictional Labor Market

par

Jonathan Créchet

Département de sciences économiques

Faculté des arts et sciences

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à Nathalie et à mes parents, Danielle et Michel

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Résumé

Cette thèse analyse l'effet de la législation de protection de l'emploi sur le taux de chômage, les salaires et la productivité des entreprises. En particulier, je m'intéresse dans cette thèse à l'effet de la réglementation des licenciements et des contrats de travail temporaires. Cette question de recherche est motivée par le fait que dans de nombreux pays de l'OCDE, la législation combine des coûts de licenciements élevés et des restrictions faibles sur les contrats temporaires, ce qui entraîne, d'après un certain nombre d'économistes, une segmentation du marché du travail.

Le premier chapitre défend l'idée qu'il est important de comprendre les mécanismes qui expliquent le choix des entreprises de signer des contrats temporaires ou permanents afin d'évaluer l'effet de la protection de l'emploi. Ce chapitre analyse un problème de contrat dynamique entre un travailleur averse au risque et un employeur neutre vis-à-vis du risque. Dans ce chapitre, je soutiens notamment que le choix du type d'emploi est déterminé par un arbitrage entre les gains associés au partage du risque qu'offre un emploi permanent et les gains associés à la flexibilité qu'offre un emploi temporaire.

Le deuxième chapitre construit un modèle du marché du travail caractérisé par des frictions de recherche et d'appariement, dans lequel le contrat dynamique du chapitre 1 est intégré. Je propose ainsi un modèle dans lequel l'allocation des agents au sein des différents types d'emplois est déterminée de façon endogène par des considérations reliées au partage du risque. Le modèle, calibré pour reproduire les caractéristiques du marché du travail en France durant les années 2000, suggère que les contrats temporaires ont tendance à augmenter la productivité des entreprises mais également le taux de chômage.

Le dernier chapitre propose un modèle de cycle de vie visant à évaluer les effets des coûts de licenciement sur l'emploi et les salaires en fonction du niveau d'éducation et

d'expérience. Le modèle est calibré sur les données d'enquête sur la main d'œuvre en France durant les années 2000. Une série d'expériences contrefactuelles indiquent que les coûts de licenciement ont un effet négatif sur l'emploi, concentré principalement sur les jeunes travailleurs avec un niveau d'éducation faible. En revanche, cet effet semble être négligeable pour les travailleurs avec un niveau d'expérience et d'éducation élevé.
Mots-clés : Marché du travail, Chômage, Législation de protection de l'emploi, Coûts de licenciement, Emploi temporaire, Contrat dynamique, Partage du risque, Frictions de recherche et d'appariement, Cycle de vie.

Abstract

This thesis analyzes the effect of employment protection on labor market outcomes. The thesis focuses on the impact of firing restrictions and the regulation of temporary contracts. In many OECD countries, the employment protection legislation combines high firing restrictions and relatively lax regulation of temporary jobs which is, according to several economists, a source of labor market segmentation.

The first chapter argues that analyzing the effect of employment protection requires to understand how economic agents choose between permanent and temporary contracts. This chapter examines a dynamic employment contract between a risk-averse worker and a risk-neutral firm. I argue in this chapter that the choice between a permanent and a temporary contract is driven by a trade-off between efficient risk-sharing and flexibility.

The second chapter builds a model of the labor market with search frictions, in which the contracting problem of chapter 1 is embedded. Thus, this chapter proposes a model in which the allocation of agents into permanent and temporary jobs is endogenous to risk-sharing considerations. The model is calibrated to the features of the French labor market during the 2000s and indicates that temporary contracts tend to increase productivity but unemployment as well.

The third chapter proposes a life-cycle model to evaluate the effect of firing costs across different experience and education groups. The model is calibrated using a French labor force survey dataset. Policy experiments suggest that firing costs have a negative effect on employment, which is concentrated on low experience and education workers.

Keywords : Labor Market, Unemployment, Employment protection legislation, Firing costs, Temporary employment, Dynamic contract, Risk-sharing, Search and matching frictions, Life-Cycle.

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Introduction

In several OECD countries, the labor market is characterized by the coexistence of permanent, open-ended contracts subject to strict firing restrictions and temporary, fixed-term contracts. Hence, in these economies, the employment protection is dual or asymmetric as these contracts are associated with different layoff restrictions. Many authors argue that this asymmetry of the legislation leads to the segmentation of the labor market between permanent and temporary workers (e.g. Bentolila et al. (2012b)). The presence of a strict employment protection increases the stability of permanent, open-ended contracts, but high firing costs incentivize employers to rely on temporary contracts to adjust labor inputs. In France and Spain, for instance, temporary jobs account for the vast majority of flows in and out of employment ; as a result, in these countries, temporary workers face a high risk of unemployment compared to those with an open-ended contract, and transitions to permanent jobs are quite low (Cahuc et al., 2016a).

The asymmetry associated with employment protection in these countries is arguably the result of several labor market reforms implemented since the 1980s. These reforms are considered "partial", in the sense that they have eased restrictions on hiring in temporary contracts, but have left unchanged the firing costs associated with regular jobs (Boeri, 2011). The introduction of temporary contracts in Europe was one of the major policies aimed at lowering unemployment and has therefore attracted a great deal of interest from researchers. Many papers have adopted the Diamond-Mortensen-Pissarides (thereafter, DMP) framework to analyze the consequences of these partial reforms. An important part of these papers have concluded that the presence of a dual employment protection system is likely to be associated with lower employment, productivity and welfare (e.g. Cahuc and Postel-Vinay (2002), Blanchard and Landier (2002), Boeri and Garibaldi (2007), Bentolila et al. (2012a)). Prominent authors have recommended the implementation of major reforms, aimed at mitigating the asymmetry of the employment protection system in European countries (e.g. Blanchard and Tirole (2003)). However, such reforms have a high political cost that requires a proper evaluation of the costs and the benefits associated with the presence of firing costs and temporary contracts.

In this thesis, I propose some tools to do so. The **chapter 1** is motivated by the fact that in existing models of the labor market analyzing the effect of a dual employment protection legislation, the source of the gains associated with the firing costs is not fully understood. Indeed, in the DMP model, firing costs constitute a waste for new matches, which makes difficult to understand the choice between permanent and temporary contracts. Hence, I propose to analyze a dynamic contracting problem between a risk-averse worker and a risk-neutral employer, in an environment in which commitment is limited. In this environment, the firing cost constitutes a commitment device which makes the employer able to promise the worker a stable job but makes the adjustment of labor inputs costly. Using this argument, I propose a model in which the choice between a permanent and a temporary contract is an outcome of the risk-sharing problem faced by the agents. I argue that the choice between the contracts is driven by a trade-off between the gain of the flexibility of a temporary job and the gain of better risk-sharing of a permanent job.

In **chapter 2**, I propose a model to evaluate the macroeconomic effects of temporary jobs and firing costs. I nest the dynamic contracting problem of chapter 1 in an equilibrium model of the labor market with search frictions. This allows me to propose a framework in which workers and firms sort endogenously into permanent and temporary jobs. Then, the model is suitable to evaluate whether labor marker reforms easing restrictions on temporary contracts result in higher job creation or instead in the crowding out of permanent contracts. My quantitative model, calibrated on the French economy, indicates that temporary contracts tend to increase productivity and output but to decrease the employment rate by increasing job destruction flows. My quantitative results also suggest that the firing costs, by acting as a commitment device, slightly increase welfare among employed *and* unemployed workers.

Finally, in **chapter 3**, I propose a life-cycle equilibrium search model to analyze the effect of employment protection on labor market outcomes across experience and education groups. This work is motivated by the fact that existing work generally focuses on the aggregate effect of temporary contracts and firing costs. The model includes human capital accumulation and information frictions about workers' ability. I calibrate the model by the method of simulated moments, using a French labor survey dataset. The quantitative results indicate that firing costs in France increase the unemployment rate for young workers with low education, and generates losses in wages that are persistent over the life-cycle.

Chapitre 1

Dynamic Employment Contract with Firing Costs

1.1 Introduction

In several OECD countries, the labor market is divided between permanent and temporary jobs. Temporary jobs represent a significant share of total employment and job creation in many European countries. [1] Workers in these economies face challenges transitioning from temporary jobs to long-term, permanent jobs. These challenges are particularly strong in countries where layoffs from permanent jobs are highly regulated (Bassanini and Garnero, 2013). This segmentation of the market between permanent and temporary jobs is widely perceived to be harmful to social cohesion and macroeconomic efficiency and is considered to be a major concern for public policy (Bentolila et al., 2012b; Eichhorst et al., 2016). [2]

The spread of temporary jobs in Europe is the result of a set of labor market reforms that have eased restrictions on temporary contracts after the 1980s but have left the

1. Temporary jobs represent 14% of dependent employment in European Union in 2015 (OECD, 2017). Cahuc et al. (2016a) and Fialho (2017) report that in the case of Spain and France, 90% of flows into employment corresponds to entry into temporary jobs in the 2000s and the 2010s.

2. It is often argued that the combination of high firing restrictions and temporary contracts generates excess turnover on the labor market which is detrimental to workers' welfare (Blanchard and Landier, 2002) and employment (Cahuc and Postel-Vinay, 2002; Bentolila et al., 2012a). It is also arged that this combination generates asymmetric adjustment costs which distort firms' labor demand and may result in lower productivity (Boeri and Garibaldi, 2007).

regulation on permanent employment largely unchanged (Boeri, 2011). These reforms were aimed at fostering job creation, and therefore increasing the rate of employment. Since the introduction of temporary jobs was one of the major policies implemented in response to high unemployment in continental Europe, it drew a lot of attention among researchers (Faccini, 2014). However, the effect of these reforms on employment and output remains uncertain because the prevalence of temporary contracts has been associated with not only job creation but also a higher rate of job destruction as they are not subject to the same firing restrictions imposed on permanent contracts.

Hence, an accurate analysis of the effect of temporary contracts on employment and output requires an evaluation of the degree of substitution between these two types of jobs in the economy. This, in turn, requires an understanding of the trade-offs that firms and workers face when choosing between permanent and temporary jobs. To this end, I analyze in this chapter a dynamic contracting problem between a risk-neutral employer and a risk-averse worker, in an environment with idiosyncratic productivity shocks. The employer has access to two different contracts : a contract with high firing costs, that I call the *permanent contract*, and a contract with no firing cost, called the *temporary contract*. As in Thomas and Worrall (1988), I consider an environment of limited commitment, where agents are allowed to renege on the contract whenever they deem it in their self-interest.

Under limited commitment, the firing cost associated with the permanent contract plays two distinct roles. On the one hand, it constitutes a commitment device which allows the employer to credibly promise the worker insurance against a possible drop in productivity. On the other hand, this requires retention of the worker when productivity is low, which is costly to the firm. By contrast, in a temporary job, the employer can terminate the contract at no cost. This makes the temporary job riskier than a permanent job for the worker. Hence, the employer needs to pay a wage differential to compensate the worker for that risk. Therefore, when choosing between contracts, the employer trades-off the gain of risk-sharing associated with the permanent contract against the flexibility of separation provided by the temporary contract. I show that the choice of contract depends on the distribution of the surplus between the agents. When the share of surplus extracted by the worker increases, the gain of insurance associated with the permanent contract dominates the gain of flexibility provided by the temporary contract. As a result, workers to whom the employer promises a high value compared to the value of unemployment are more likely to obtain a permanent contract, which delivers a higher degree of job stability and hence more insurance than the temporary contract.

There is a vast literature analyzing the effect of temporary jobs in frictional labor markets (e.g. Blanchard and Landier (2002); Cahuc and Postel-Vinay (2002); Bentolila et al. (2012a); Faccini (2014)). However, only a subset of these papers analyzes the choice between permanent and temporary jobs. In the canonical Diamond-Mortensen-Pissarides (DMP) framework, firing costs constitute a waste for a new match, and the agents always prefer to sign a temporary contract. [3] Hence, in this literature, the DMP model has been adapted to understand the choice between contracts. Those papers have followed different strategies. Some of them assume a constant wage. [4] Other papers rely on assumptions that generate exogenous gain in signing a permanent job that counteract the firing costs. [5]

In the model that I propose, which is inspired by the literature analyzing dynamic risk-sharing contract under limited commitment, (e.g. Thomas and Worrall (1988); Kocherlakota (1996); Gauthier et al. (1997); Koeppl (2007)), the gain of signing a permanent contract is endogenously determined by the firing cost. The only distinction between the permanent and the temporary job is the difference in the firing cost, and the choice between the contract is an outcome of the dynamic contracting problem. Since the choice between the contracts is an endogenous outcome of the risk sharing problem, this model can be used to conduct various policy experiments. Moreover, because firing costs are associated with potential welfare gains, this model is suitable to analyze how the regulation

3. In the standard DMP model with stochastic productivity shocks, the presence of firing restrictions generate expected separation costs that are anticipated by the agents and thus these restrictions reduce the surplus of a new match. When the wage is flexible, the employer can pass to the worker part of the expected costs of separation and make him prefer the temporary contract.

4. In Alonso-Borrego et al. (2005). Berton and Garibaldi (2012) wages are constant, hence employment protection increases the attractiveness from the worker perspective, and reduces firms' search costs.

5. Caggese and Cuñat (2008) assume that permanent workers are more productive than temporary workers. In Cao et al. (2013) and Fialho (2017), the rate of arrival of outside offers on the job is assumed to be higher for temporary than permanent workers. Guglielminetti and Nur (2017) assume that temporary jobs are affected more often by productivity shocks than permanent jobs because a new match specific productivity is drawn when a temporary contract ends. Cahuc et al. (2016a) and Cahuc et al. (2016b) propose a model with stochastic duration of production opportunities and endogenous job duration, in which the trade-off between the permanent and the temporary contract is due to the presence of a cost of signing a contract.

on contracts affects the well-being of agents. [6]

The paper is organized as follows. Section 2 describes the environment and section 3 presents the employer's problem. Section 4 analyzes the design of the optimal contract, including the choice between a permanent and a temporary contract. I conclude in section 5.

1.2 Environment

Time is discrete with an infinite horizon and is indexed by t. The economy is populated with risk-neutral employers and risk-averse workers with discount factor β. The preferences of workers are represented by the utility function $u(c_t)$, where c_t is consumption at time t. The utility function is strictly increasing, strictly concave and twice continuously differentiable. Workers cannot save, and they consume their entire income at each period. Employers have access to a production technology using labor as the sole input. Each time period, workers are endowed with one indivisible unit of labor. To produce, a worker and an employer have to be paired together in a match. The productivity of a match is denoted by z_t and is a random variable. During an ongoing employment relationship, iid productivity shocks occur at each time period with probability λ. After a productivity shock, a new value of z is drawn from a continuous density $g(z)$ which is strictly positive on support $[z_l, z_h]$.

Contract

At the beginning of an employment relationship, the worker and the firm agree on a *contract*. A contract starting at time t, which is denoted by σ_t, specifies a set of actions contingent on the possible histories of z_t. A *t-history* z^t is a sequence of realizations of the stochastic term from period 0 to period t, that is $z^t \equiv \{z_{t_0}, z_{t_0+1}, ..., z_t\}$. A contract σ_t associates each possible realization of z^∞ with a *layoff rule*, which is a time horizon $\tau(z^\infty)$ such that the worker is laid-off at time $t' = \tau(z^\infty)$, and a sequence of *wage payments* to the worker $\{w_t(z^\infty), w_{t+1}(z^\infty), ...w_{\tau(z^\infty)}(z^\infty)\}$. Separations are costly : the employer pays a firing

6. In the second chapter of this thesis, I will exploit this framework to build an equilibrium model of the labor market with agents sorting endogenously into permanent and temporary jobs, that I will use to analyze the macroeconomic effect of the employment protection legislation in France.

cost F when the worker is laid-off.[7]

Now, I examine the payoffs of a contract. The expected lifetime value of a worker holding a contract σ_t at time t, expressed in its sequential formulation is

$$V_t(\sigma_t) = E_t\left[\sum_{s=t}^{\tau} \beta^{s-t} u(w_s) + \beta^{\tau-t} U\right], \tag{1.1}$$

where E_t is the expectation formed over the distribution of z^{∞}, conditional on history $z^t = \{z_0, z_1, ..., z_t\}$. U denotes the value of the outside option of the worker, which is the value of leaving the match and going back to unemployment.[8]

The profits of an employer's holding a contract σ_t at date t can be written as

$$J_t(\sigma_t) = E_t\left[\sum_{s=t}^{\tau} \beta^{s-t}(z_s - w_s) + \beta^{\tau-t}(J_0 - F)\right],$$

where J_0 denotes the value of a vacant job F is the firing cost paid by the employer in case of a layoff. In what follows, the analysis will focus on the interaction between F, the employer's outside option and the contract design. Hence, I will simply set $J_0 = 0$.

The contract is subject to a set of constraints. The first constraint, referred as the *promised keeping constraint*, specifies that the contract should deliver to the worker a lifetime value greater than a given *value promised*, denoted by V.[9] Moreover, I assume that commitment is limited (Thomas and Worrall, 1988; Kocherlakota, 1996). The contract should satisfy a set of participation constraints : at any point in time after the beginning of the employment relationship, the agents should receive a greater lifetime value by staying in the match than going back to their outside option. After the realization of an history

7. Later, when I introduce the distinction between the permanent and the temporary job, the level of the firing cost will be a function of the type of contract. For now, in order to present the general risk-sharing problem, I do not distinguish between the different types of contracts.

8. The value of unemployment is assumed to be independent of time.

9. In this chapter, the value promised associated with the contract is exogenous. Essentially, the objective of this chapter is to analyze how the value promised at the beginning of the contractual relationship affects the choice between the permanent and the temporary contract. In chapter 2, in which the contracting problem is nested in an equilibrium model of the labor market with random search frictions, the value promised will be determined by bargaining.

such that both participation constraints cannot be simultaneously satisfied, the agents must separate. [10] Importantly, I assume that the lower bound of the support of z', z_b, is sufficiently low to ensure that the probability associated with the occurrence of histories leading to a separation is strictly positive. [11]

The problem has an infinite state-space, constituted by the set of possible histories of the stochastic term z_t. Following Spear and Srivastava (1987) the optimal contracting problem is analyzed in its recursive form, in which the promised value represents a predetermined state variable. The analysis follows the same timing as Thomas and Worrall (1988), in which the realization of the current state is observed before choosing the terms of the recursive contract. In this formulation, the set of choice variables is the current wage and the set of actions contingent on the realization of the stochastic term in the subsequent period, z'. In its recursive form, the contract is given by

$$\sigma = \left\{ w, S, (V(z'))_{z' \notin S} \right\},$$

where w is the current wage, S is the set describing the separation rule and $V(z')$ is the set of promised values contingent on the realization of z'. The separation rule is represented by a set $S \subset [z_b, z_h]$, such that the worker is laid-off when $z' \in S$. Hence, the values promised $V(z')$ are contingent on the realizations of z' lying outside of S.

Permanent and temporary contract

Now I introduce the distinction between the permanent and the temporary contracts. Two types of contracts are available. The type of contract is indexed by $c \in \{P, T\}$. A contract of type c, written σ_c, is a contract with firing cost $F_c \geq 0$, which is paid by the employer upon separation of the match. The **permanent contract** (PC), denoted by σ_P is a contract

10. After the realization of a negative productivity shock, it might be the case that there exists no wage sequence such that the worker is willing to stay matched and the employer makes enough profits to find profitable to keep the worker. In such a case, the separation is associated, ex-post, with efficiency gains. Because of limited commitment, it is not possible for agents to credibly promise to keep the match in this type of situation. The separation decision will be characterized in proposition 1.

11. This assumption is crucial to generate a trade-off between a permanent and a temporary contract : the choice of contract will arise from the decision to keep the match or not during states associated with these averse shocks. Otherwise, there is no reason for separation, and the firing cost is only commitment device. In this case, the permanent contract is always trivially preferred to the temporary contract.

with strictly positive firing costs : $F_P = F > 0$. The **temporary contract** (TC), denoted by σ_T has zero firing cost : $F_T = 0$. Given the presence of those two different contracts, the employer's problem consists of two steps. First, the employer chooses between the permanent and the temporary contract, given the value promised to the worker. Second, he designs the optimal contract as described above, conditional on $c \in \{P, T\}$.

There are no severance payments : firing costs are simply a penalty paid by the employer upon a layoff, without any transfer to the worker or the government. The analysis aims at understanding the effect of the firing cost as a commitment device, and how it interacts with the provision of insurance to the worker through job security. [12]

1.3 Employer's problem

As explained above, the contracting problem can be analyzed in two steps : first, the employer chooses the contract and then designs the wages and the separation rule. I will proceed backward : prior to analyzing the choice of job type, I characterize the optimal contract conditional on c (or equivalently, conditional on F_c).

Consider a match in state (V, z), with a contract of type $c \in \{T, P\}$. The employer's problem is to maximize his expected profits by choosing the terms of σ_c according to

12. In fact severance payments might have important implications in the design of the optimal insurance contract. Indeed, employers can substitute severance payments for job security. Our implicit assumption here is that there is a friction preventing full insurance through severance payments. This assumption allows me to analyze how employers use job stability to provide insurance to workers and how this explains the choice between the contracts. This aspect is discussed further in the section analyzing the optimal contract and the choice between the permanent and the temporary job.

$$J_c(V,z) = \max_{\sigma_c \in \Gamma_c(V,z)} z - w + \beta E_{z' \notin S}\Big[J(V(z'),z')\,|\,z\Big] - \beta \Pr(z' \in S|z) F_c, \tag{1.2}$$

such that σ_c belongs to the set of feasible contracts, $\Gamma_c(V,z)$, given by

$$\Gamma_c(V,z) = \Bigg\{ \sigma_c \,|$$

$$u(w) + \beta E_{z' \notin S}\Big[V(z')\,|\,z\Big] + \beta \Pr(z' \in S|z)\, U \geq V \tag{1.3}$$

$$V_c(z') \geq U \text{ for } z' \notin S \tag{1.4}$$

$$J_c(z') \geq -F_c \text{ for } z' \notin S \Bigg\} \tag{1.5}$$

First, observe the employer's profit function (1.2). Each period, the employer receives the current value of output, z, net of the wage paid to the worker, w, as prescribed by the contract. The employer's expectation is formed on the set of promised values for the next period, $V(z')$, contingent on the realizations of z' lying outside of the separation set S, and from the value associated with a separation. A separation occurs when z' reaches the set S, in which case the employer pays the firing cost F_c, that depends on the type of contract.

Now, examine the set of feasible contracts, $\Gamma_c(V,z)$. The first constraint, (1.3), is the promised keeping constraint, which is formed from the worker's lifetime value associated with the contract, which should be at least equal to the value promised, V. Similarly to the employer's profit function, the worker's expectation for the next period is formed over the set of values promised conditional on the continuation of the match and from the probability of a separation. The constraints (1.4) and (1.5) are the worker's and the employer's participation constraints, respectively. Those constraints are only relevant for the realizations associated with a continuing match, which lie outside of the set S.

It is important to note that the employer's constraint (1.5) depends on F_c. The firing cost deteriorates the employer's outside option and thus relaxes his participation constraint. Therefore, the set $\Gamma_c(V,z)$ depends on the contract type c through the employer's participation constraints (1.5) and it depends on V through the promise-keeping constraint. [13]

Finally, the employer chooses the type of contract that yields the higher profit conditional on V and z. Given the optimal contracts of types P and T, $\sigma_P^*(V,z)$ and $\sigma_T^*(V,z)$, the contract choice satisfies

$$J(V,z) = \max\Big\{J_P(V,z), J_T(V,z)\Big\}. \tag{1.6}$$

The following section describes the solution associated with a contract σ_c^* and the choice between the permanent and the temporary contract.

1.4 Optimal contract

1.4.1 Wage dynamics and separation rule

Before analyzing the choice between the contracts, I characterize the optimal wage and separation rules associated with a contract type $c \in \{P, T\}$. The solution prescribes a constant wage unless one of the participation constraints is binding, in which case it is adjusted to avoid a separation. In addition, a layoff occurs when both participation constraints cannot be simultaneously satisfied. The following proposition characterizes the optimal wage dynamics and separation rule.

13. In addition, it depends on the stochastic term z because of the persistence characterizing the match productivity.

Proposition 1. ***Wage dynamics and separation rule***. *The optimal contract of type $c \in \{T,P\}$, with promised value V and productivity z is characterized by the following features :*

- *there exists a unique value $\underline{z}_c \in Z$, such that a separation occurs if and only if $z' < \underline{z}_c$, independently of the previous state z;*
- *for all states $z, z' \geq \underline{z}_c$, the current wage is higher than the reservation wage $\underline{w}$, which is constant across states and independent of the contract type;*
- *the current wage, $w_c(V)$ is independent of z and is strictly increasing in V; the subsequent wage associated with $z' \geq \underline{z}_c$ is given by*

$$w_c(V(z'), z') = \begin{cases} w_c(V) & \text{if } \underline{w} \leq w(V) \leq \overline{w}(z') \\ \overline{w}_c(z') & \text{if } w(V,z) > \overline{w}_c(z') \end{cases}$$

where $\overline{w}_c(z')$ is the wage that solves the employer participation constraint with equality in state z'.

Proof. See appendix 3.6.1 □

In the optimal contract, the wage is kept constant as long as the employer's participation constraint, (1.5) is slack. When it is binding, the wage decreases in order to avoid separation. Indeed, the employer's constraint is characterized by a threshold in the wage, $\overline{w}_c(z')$ for each state $z' \geq \underline{z}^c$. A wage cut occurs in states such that the current wage is above that threshold.

The worker's reservation wage is constant across states. This is a consequence of the fact that the productivity shock is idiosyncratic to the match. [14] Moreover, the reservation wage is the same in the permanent and in the temporary contract, essentially because the employer's participation constraint does not play any role in the future dynamics of the wage. When the worker is paid the reservation wage, which represents the lower possible

14. Indeed, the worker's outside option is independent to idiosyncratic shocks to the match productivity. This contrasts with Thomas and Worrall (1988), in which the worker's autarky value depends on labor market opportunities on the spot market wage. The worker's outside option also might also depend on aggregate conditions (Rudanko, 2011). This is also the case for shocks to the worker's productivity (for instance in the case of stochastic human capital accumulation, Lentz and Roys (2015)). In these types of environment, the optimal dynamic contract specifies a wage increase when the worker's constraint is binding due to an improvement in its outside option.

wage paid in the set of feasible contracts, he expects to receive a flat payment until the end of the job. In such a state, the worker's value is independent of the commitment ability of the employer and, therefore, of the firing cost. [15]

Separations occur in states in which both participation constraints cannot be satisfied simultaneously, which is the case when $J(V,z') < -F_c$ and $V = U$. If the employer's profits are lower than the value of the firing cost when the worker is paid his reservation wage, it is optimal (ex-post) to separate. As it is explained in appendix 3.6.1, the set of z' associated with separations is characterized by a threshold value, denoted by $\underline{z}_c$ and characterized by

$$\underline{z}_c = \{\, z \in [z_l, z_h] \mid J_c(z', V) = -F_c \text{ for } V = U \,\}.^{16}$$

The following lemma proposes an alternative characterization of the optimal contract of type c, that I will use thereafter to compute the employer's value function and the wage and to provide a graphical representation of the optimal contract.

Lemma 1. *Let V and $w_c(V)$ be the value promised and wage today. Denote the highest value of z' such that the employer's constraint is binding, by $z_c(V)$, which is a strictly decreasing function of V. The wage paid tomorrow, $w_c(V(z'))$, is*

$$w_c(V(z')) = \begin{cases} w_c(V) & \text{if } z' \geq \tilde{z}_c(V) \\ \overline{w}_c(z') & \text{if } \underline{z}_c \leq z' < \tilde{z}_c(V) \end{cases}$$

15. If the model is extended in order to take into account on-the-job search, the worker reservation will be dependent on the contract type. Indeed, with on-the-job search, the worker expects a wage increase in the future, either through renegotiation or transitions to new employers (Postel-Vinay and Robin (2002) and Cahuc et al. (2006)). Then, the employer's participation constraint will have an incidence on the expected trajectory of the wage. Moreover, the reservation wage will depend on the state z. Indeed, if we allow employers to match outside offers their renegotiation behavior will depend on the state z, which will affect their willingness to pay for the worker. As it is shown in Postel-Vinay and Robin (2002), the employer willingness to pay is a key determinant in the determination of the wage experience profile. Hence the worker will have a higher reservation wage in bad states, where the employer willingness to pay is lower.

16. The existence of the separation cutoff requires that $J_c(U,z') < -F_c$ for $z' = z_b$ to ensure that there is a measurable subset of the support of z' such that the employer's and the worker's constraint cannot be jointly satisfied. This is equivalent to the assumption that the lower bound of the support of z' is low enough to generate histories leading to a separation.

Moreover, the worker's value in the optimal contract evolves following

$$V_c(z') = \begin{cases} V & \text{if } z' \geq \tilde{z}_c(V) \\ \overline{V}_c(z') & \text{if } \underline{z}_c \leq z' < \tilde{z}_c(V) \\ U & \text{if } z' < \underline{z}_c \end{cases}$$

where $\overline{V}_c(z')$ is the value promised that solves the employer's participation constraint with equality given z'.

Proof. See appendix 3.6.2. □

This lemma states that the wage dynamics can be characterized in terms of a cutoff value, $\tilde{z}_c(V)$, such that a wage cut occurs for $z' < \tilde{z}_c(V)$. The worker's value stays constant when the employer's constraint is slack, that is when the realization of z' is above the threshold for wage cut $\tilde{z}_c$.[17] Otherwise, he obtains utility $\overline{V}(z')$ or goes to unemployment. This characterization is useful for the next proposition.

Lemma 2. *The employer's value function in contract $c \in \{P, T\}$, with value promised V and productivity z solves*

$$J(V,z) = z - w(V) + \beta(1-\lambda)J(V,z) + \beta\lambda\left\{\int_{\tilde{z}_c(V)}^{z^h} J(V,z')dG(z') - G(\tilde{z}_c(V))F_c\right\}, \tag{1.7}$$

and the associated wage solves

$$w(V) = u^{-1}\left\{V - \beta\Big[1 - \lambda G(\tilde{z}_c(V))\Big]V - \beta\lambda\int_{\underline{z}_c}^{\tilde{z}_c(V)} \overline{V}(z')dG(z') - \beta\lambda G(\underline{z}_c)U\right\}. \tag{1.8}$$

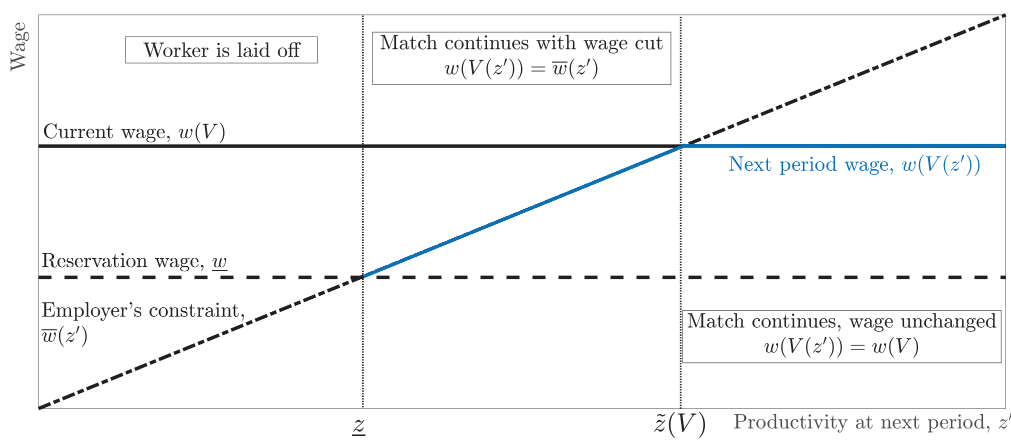
These expressions are obtained from the characterization of the optimal contract in lemma 1. With probability $1 - \lambda G(\tilde{z}_c(V))$, which is the probability that the employer's constraint is slack, the wage and the value of the worker stay constant. In the case where the constraint

17. The fact that utility stays constant when the employer's constraint is slack comes the fact that productivity shocks are iid. This assumption makes the probability of wage cut and separation constant across states. Hence, the value of the worker is fully determined by the wage and is independent of the value of z today. If the stochastic term were a first order Markov process, it would not have been the case : the degree of risk faced by the worker would have been a function of z instead. In the case where z is an AR-1 process, for instance, the probability of wage cut and separation would have been a decreasing function of z. Therefore, the worker's value would be increasing with z conditional on the wage.

is binding, the profits function is equal to the employer's outside option (and so, to the firing cost), and the worker receives the value $\overline{V}(z')$ conditional on z'.[18] With probability $\lambda G(\underline{z}_c)$, the worker is laid-off and gets the value of unemployment. Writing the profits and the wage as functions of the thresholds $\tilde{z}_c(V)$ and $\underline{z}_c$ as in lemma 2 will be useful in analyzing the effect of F on the design of the optimal contract and the choice of c.

Figure 1.1 illustrates the solution associated with a contract of type c. The figure represents the wage today, $w_c(V)$ and the wage tomorrow, $w_c(V, z')$ as functions of z', for V given. It also represents the reservation wage, $\underline{w}$ and the wage associated with the employer's constraint, $\overline{w}_c(z')$, as functions of z'.

Figure 1.1 – The wage dynamics and the layoff rule in the optimal contract



The current wage $w_c(V)$ and the reservation wage $\underline{w}_c$, which are independent of the shock at the next period are constant functions of z'. The wage at next period $w_c(V(z'))$, represented in the blue line, is an increasing function of z'. This wage, represented in the blue color, is equal to the maximum between $w_c(V)$ and the function $\overline{w}_c(z')$. The interval $[\underline{z}, \underline{z}_c)$ corresponds to the realizations of z' leading to a layoff, and the interval $[\underline{z}_c, \tilde{z}_c(V))$ corresponds to the realizations of z' leading to a wage cut given V.

The threshold $\tilde{z}_c(V)$ depends on the type of contract signed by the worker and the firm, because of the difference in the firing cost. Indeed, it depends on the employer's

18. For any $z' \in [\underline{z}_c, \tilde{z}_c)$, the employer's profits are equal to F_c because the wage is adjusted downward in order to ensure that the employer's constraint is satisfied with equality. As a result, the worker's wage and value function vary monotonically with z' in this interval.

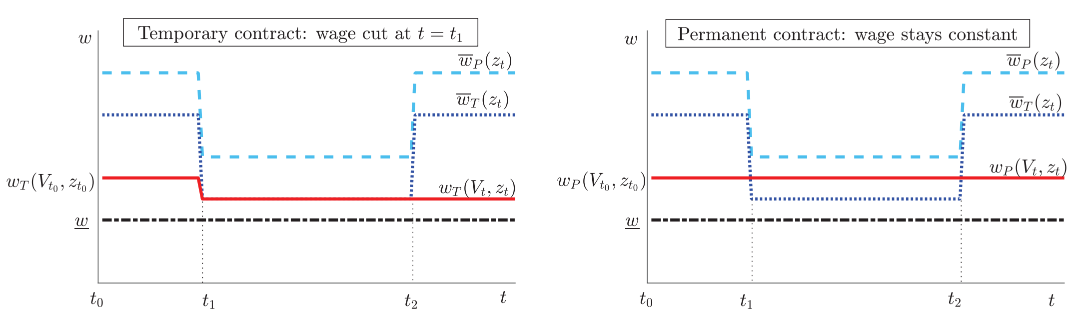
participation constraint, which is directly affected by the firing costs, the probability of a wage cut and of a layoff will also depend on the type of contract, as stated in the following lemma.

Lemma 3. *The threshold values for separation and wage cuts satisfy* $\underline{z}_P \leq \underline{z}_T$ *and* $\overline{w}_P(z') \geq \overline{w}_T(z')$.

Proof. See appendix 3.6.3 □

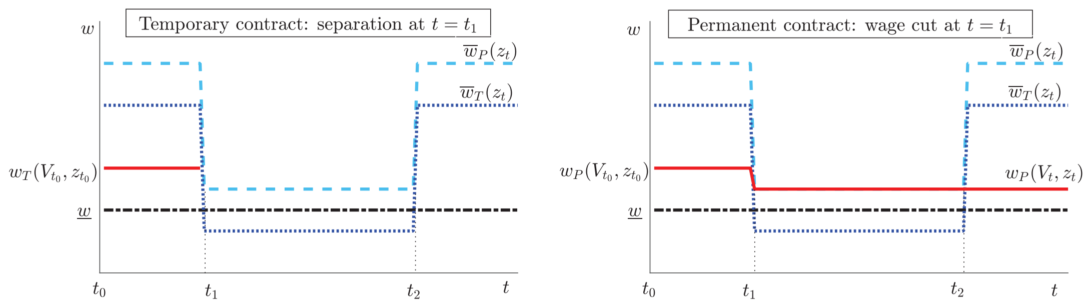
Given value promised V, the probability of a **separation** or a **wage cut**, is lower in the permanent than in the temporary contract. The firing cost makes the permanent contract less risky from the perspective of the worker. By relaxing the employer's participation constraint, it decreases the probability of a wage cut and the risk of unemployment. The behavior of the wage and the separation rule that are associated with a permanent and a temporary job are illustrated in figures 1.2 and 1.3. These figures show how the wages $w_P(V)$ and $w_T(V)$ and the functions $\overline{w}_P(z')$ and $\overline{w}_T(z')$ react to a temporary negative shock to z. In the illustrated case, the negative productivity shock occurs at period t_1 and lasts until period t_2. The figure 1.2 illustrates the consequence of what I call a *small* shock, such that $\overline{w}_T(z') < w(V) < \overline{w}_P(z')$ at t_1, resulting in a wage cut in the temporary contract only. In figure 1.3, I represent a *large* productivity shock, which is a shock such that $\overline{w}_T(z') < \underline{w} < w_P(V) < \overline{w}_P(z')$ at t_1, resulting in a separation in a TC and a wage cut in a PC.

Figure 1.2 – Illustration of a *small* negative productivity shock in a temporary and a permanent job



These differences in the wage dynamics and in the layoff rule between the contract affect the current wage $w_c(V)$. The following lemma compares the wages paid in the

Figure 1.3 – Illustration of a *large* negative productivity shock in a temporary and a permanent job



permanent and the temporary job. Conditional on V, the employer pays a wage differential in a temporary job.

Lemma 4. *For all $V > U$, $w_P(V) < w_T(V)$. However, for $V = U$, $w_P(V) = w_T(V)$.*

Proof. See appendix 3.6.3. □

The lemma states that the employer pays a **wage differential** to compensate the worker for the risk associated with the temporary contract. I examine the wage associated with a contract type c, in state (V, z). Using (1.8), the wage function can be written as

$$w(V) = u^{-1}\Big\{ \underbrace{\big(1-\beta\big)V}_{\text{Utility under FI}} + \underbrace{\beta\lambda \int_{\underline{z}_c}^{\tilde{z}_c(V)} \big(V - \overline{V}(z')\big) dG(z')}_{\text{Compensation for wage cut risk}} + \underbrace{\beta\lambda G(\underline{z}_c)\big(V - U\big)}_{\text{Compensation for layoff risk}} \Big\}.$$

The wage in contract c is a function of three components. The first term is the instantaneous utility that the worker would obtain at each period in the case of a contract with full insurance.[19] The second component is a utility payment that the worker receives as a compensation for the risk of a wage cut. This term represents the payment that makes the worker indifferent between a full insurance contract and the contract c, given the risk of loss in income due to a wage cut. The third term represents the utility payment that compensates the worker for the expected loss in income due to a layoff. Note that this

19. In the case of full insurance, the contract prescribes a constant wage payment, equal to $w_{FI}(V) = u^{-1}\big\{(1-\beta)V\big\}$ at each time period. Note that the full insurance contract will be feasible when the cutoff $\tilde{z}_c(V)$ is lower than z_b, the lower bound of the support associated with z'. Such a contract will be obtained with an infinite firing cost, that will eliminate the employer's participation constraint.

result should not be viewed as a theoretical prediction of the model. In fact, it is primarily a intermediate result that I use to understand the choice between the two contracts. [20]

These two compensations are increasing functions of the cutoff $\tilde{z}_z(V)$ and $\underline{z}$, which are lower in the PC compared to the TC. Hence, the employer pays a higher wage given V to the temporary worker. Note that the wage differential is zero when $V = U$, which comes from the fact that the reservation wage is the same across contract types, as discussed above. [21]

Figure 1.4 illustrates the effect of the firing cost F on the design of the contract. It also illustrates the main differences between a PC and a TC. Similarly to figure 1.1, this graph represents the current wage paid in each type of contract, for a given value promised along with the wages associated with the employer's participation constraints as functions of the shock tomorrow, $\overline{w}_c(z')$, for $c \in \{T, P\}$, and with the reservation wage. The wage $\overline{w}_P(z')$ is represented by the blue dotted line. As discussed in lemma 3, the fact that the employer's constraint is relaxed due to the firing cost makes the cutoff values for wage cut and separation lower in the PC than in the TC. Hence, the wage paid to the permanent worker, $w_P(V)$, represented by the blue solid line is below the wage paid to the temporary worker, $w_T(V)$.

The wage differential is an increasing function of the promised value V because of the decreasing marginal utility of the worker. Hence, V will have a key role in the choice between the permanent and the temporary contracts. The following subsection analyzes this choice.

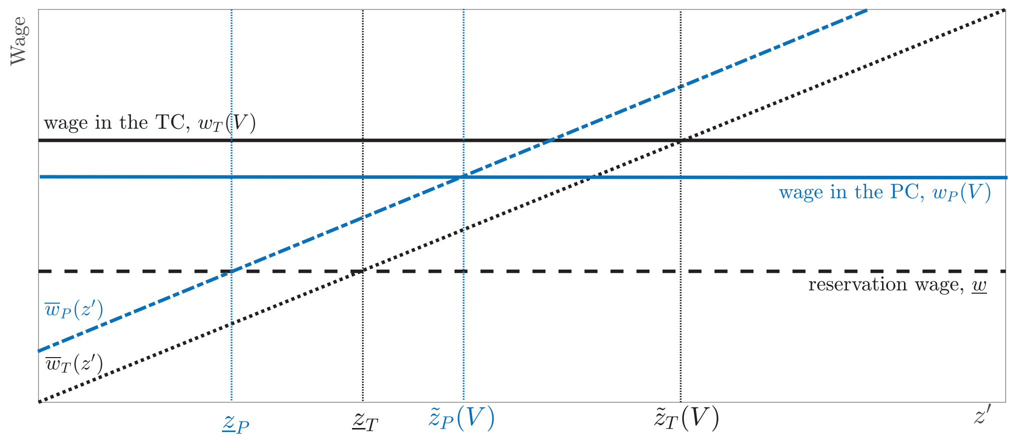
1.4.2 The choice between the permanent and the temporary contract

Given the contract designed in the employer's second stage problem (1.2), the contract type is chosen according to the first step (1.6). The following proposition analyzes how the choice between the contract depends on the value promised to the worker.

20. In the text below, in which I analyze the choice between the contracts, I will provide more details on this aspect.

21. In our environment, in which the wage is constant until the end of the match as soon as the worker receives just his outside option U, the risk of income loss due to a wage cut is obviously inexistent and the risk due to a loss in utility after a layoff as well since the worker is indifferent between staying matched and being unemployed.

Figure 1.4 – The wage dynamics and the layoff rule in the PC and the TC



Proposition 2. *There exists a unique threshold value in V, denoted by $\hat{V}$, with $\hat{V} \geq U$, such that the employer prefers a* ***permanent contract*** *if $V \geq \hat{V}$ and a* ***temporary contract*** *otherwise.*

Proof. see appendix 3.6.5. □

To examine the choice, I use (1.7) to compute the difference between the employer's profits in a PC and a TC given V, which writes as

$$\begin{aligned}\Delta J(V,z) &\equiv J_P(V,z) - J_T(V,z)\\ &= -\Delta w(V) + \beta(1-\lambda)\Delta J(V,z)\\ &+ \beta\lambda\left\{\int_{\tilde{z}_P}^{z_h} J_P(V,z') - \int_{\tilde{z}_T}^{z_h} J_T(V,z')dG(z') - G(\tilde{z}_P(V))F\right\}\end{aligned} \tag{1.9}$$

where $\Delta w(V) \equiv w_T(V) - w_P(V)$ is the wage differential paid to the temporary worker.

I will be particularly interested in the value of (1.9) for a value promised equal to the worker's value in unemployment, $V = U$. Indeed, doing so will be helpful to emphasize the costs which are specific to a permanent contract, and I will argue that for values of V close enough to U, the temporary contract will be preferred.

Using the fact that the wage differential is zero when the worker receives the value of unemployment, I write the function (1.9), evaluated at $V = U$ as

$$\begin{aligned}
\Big[1-\beta(1-\lambda)\Big]\Delta J(U,z') \quad &= \quad \beta\lambda\left[\int_{\hat{z}}^{z_h}\Delta J(U,z')dG(z')-\int_{\underline{z}^T}^{\hat{z}}J_T(U,z')dG(z')\right] \\
&+ \quad \underbrace{\beta\lambda\int_{\underline{z}^P}^{\hat{z}}J_P(U,z')dG(z')}_{\text{Expected cost of inefficient retention}} \quad + \quad \underbrace{\beta\lambda G(\underline{z}^P)(-F)}_{\text{Expected cost of separation}} \qquad (1.10) \\
&< 0.
\end{aligned}$$

where I denote by $\hat{z}$ the value of z' such that the employer makes zero profits in the PC given that $V = U$. As discussed in appendix 3.6.5, $\hat{z} > \underline{z}_T$, because the firing cost increases the cutoff value such that the employer makes zero profits when the worker is just paid the reservation wage. Therefore, the expression (1.10) is negative for all z, because $J_T(U,z') > 0$ for all $z' > \underline{z}_T$ and because $J_P(U,z') \leq 0$ for all $z' \in [\underline{z}_P, \hat{z}]$, by construction.

Expression (1.10), shows two terms that are helpful to understand the costs associated with a PC. The first is the expected cost of inefficient retention that the employer faces when he signs a permanent contract when $V = U$. The firing cost prevents separation when the employer's profits become negative, even though the worker is indifferent between staying matched and going back to unemployment. In the TC, by contrast, separations are efficient. [22]. The second term is the expected cost of separation due to the firing cost. [23]

Therefore, for $V = U$, the firing cost is a pure loss and the employer prefers the temporary contract. Indeed, when the value promised is equal to the value of unemployment, the worker is strictly indifferent between staying matched and being laid-off and so the value associated with insurance is zero. However, when V is greater than U, the value associated with job security becomes positive. Computing the derivative with respect to V of (1.9) and using the envelope condition associated with problem (1.2) yields

22. In fact, with a TC, separations are *ex-post* efficient, that is efficient after observing the realization of z'. Indeed, it might be optimal for the employer to write *ex-ante* a contract such that the match continues during bad times in order to pay to the worker a lower wage. Because of limited commitment, the employer will have to use the PC to be able to write such a contract. Essentially, the choice between the two contracts comes from a trade-off between the benefit of insurance provision through commitment to inefficient ex-post retention and the benefit of higher output through ex-post efficient separation.

23. When F is large enough to avoid separation due to a shock to z', the cost of separation is obviously zero and the only relevant term is the cost of retention.

$$\frac{\partial\Big(\Delta J(V,z)\Big)}{\partial V} = \Big[u'(w_T(V))\Big]^{-1} - \Big[u'(w_P(V))\Big]^{-1}$$
$$> 0,$$

for $V > U$, since $w_T(V,z) > w_P(V,z)$ for all $V > U$, as we saw in lemma 4. Because of decreasing marginal utility, the marginal cost of increasing V is higher with a TC, in which the degree of risk passed to the worker is higher compared to the PC. The function (1.9) is then negative for $V = U$ and strictly increasing in V. As it is continuous in V, there is a unique value such that $\Delta J(V,z) = 0$, which I denote $\hat{V}$. For this value, the following equality holds :

$$\Delta w(\hat{V}) = \beta\lambda\left[\int_{\tilde{z}_P(\hat{V})}^{\tilde{z}_T(\hat{V})} J_P(\hat{V},z')dG(z') - G(\tilde{z}_P(\hat{V}))F\right]$$

which indicates that the employer is indifferent between the two contracts when the wage differential is equal to the expected profits in a PC associated with a bad shock such that $z' < \tilde{z}_T(\hat{V})$. [24]

For $V < \hat{V}$, it is less costly, from the employer's perspective, to pay a wage differential than keeping the match during low productivity states, such that $z' < \tilde{z}_T(V)$. In such a case, the employer chooses a TC. As V increases, the wage differential becomes more important relative to the cost of keeping an unproductive match. Therefore, the PC becomes more attractive and it is chosen for $V > \hat{V}$. The temporary contract, in which separations are ex-post efficient, yields more profits conditional on the wage. In the permanent contract, the firing cost distorts (ex-post) the separation rule, but it makes the employer able to promise a higher degree of job security, which decreases the wage paid to the worker. Decreasing marginal utility makes the gains of insurance increasing with V, so the permanent contract

24. The right-hand side of this equation is the expected profits with a PC conditional on a productivity shock such that the profits in zero in the temporary contract, times the probability of the occurrence of such a shock. This equality can be obtained using the fact that $\Delta J(\hat{V},z') = 0$ for all $z' \geq z_T(\hat{V})$. Indeed, the assumption that productivity shocks are iid implies that the derivative of $J_c(V,z)$ with respect to z is equal to the constant $1/(1-\beta(1-\lambda))$ for all z and all c.

becomes more attractive as the value promised increases. In the light of this result, the following subsection discusses the connexion between the choice of contract and the wage offered to the worker.

1.4.3 The wage in a permanent and a temporary job

The lemma 4, which states that a temporary worker receives, everything else equal, a higher wage than a permanent worker should not be viewed as a prediction but instead as an intermediate result toward the proposition 2 about the contract choice. Essentially, this lemma states that the employer *would have* to pay a wage differential to convince the worker to accept a temporary contract. This does not imply that in equilibrium, a worker hired on a temporary job will be paid a higher wage than a permanent worker.[25] Essentially, this is because the wage is connected to the contract choice through the worker's value promised. The following propositions examine this connexion.

Proposition 3. *Conditional on the value promised to the worker at the beginning of the contract, the wage satisfies*

$$w(V) = \begin{cases} w_T(V) \text{ if } U \leq V < \hat{V} \\ w_P(V) \text{ if } V > \hat{V}. \end{cases}$$

Moreover, the wage function is strictly increasing in $[U, \hat{V})$ and for $V > \hat{V}$.

This proposition follows directly from the characterization of the wage in lemma 1 and from the proposition 2, on the contract choice. The discontinuity in the wage function at $\hat{V}$ is due to the fact that two different contracts are available : the employer prefers the permanent contract for $V > \hat{V}$ and the worker receives the wage $w_P(V)$; otherwise, the temporary contract is chosen and the worker gets $w_T(V)$.

Note that the maximum wage received by the worker conditional on being hired on a temporary job is $\overline{w}_T \equiv \lim_{V \to \hat{V}} w_T(V)$ and that $\underline{w}_P \equiv w_P(\hat{V})$ is the lower bound on the

25. This would be counterfactual, as there is evidence indicating that permanent workers receive a higher wage than temporary workers, conditional on observables (e.g. Berson (2018)). More generally, Bonhomme and Jolivet (2009), using a panel data from European countries, found that workers do not receive wage differential to compensate for lack of job security.

wage conditional on signing a permanent contract. We have that $\overline{w}_T > \underline{w}_P$, which is a consequence of the presence of the wage differential (lemma 4) : the wage offered in case of hiring on a temporary contract is higher in the neighborhood of $\hat{V}$. However, this is not the case outside of this neighborhood, as stated in the next proposition.

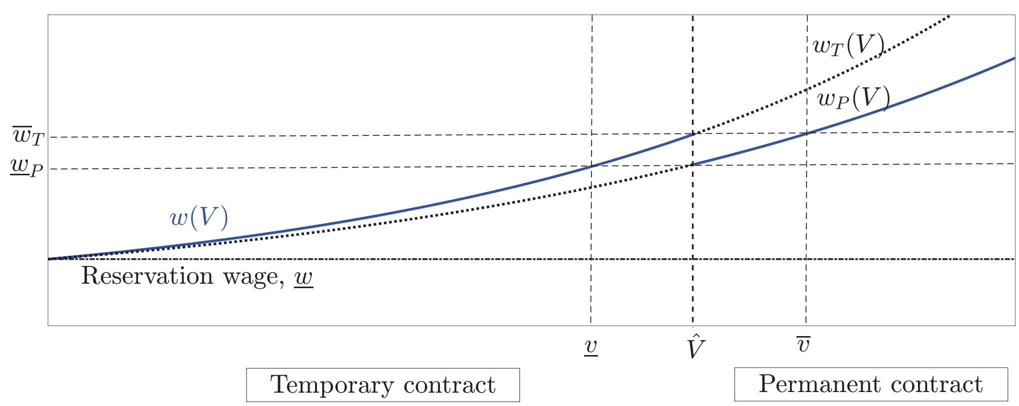
Proposition 4. *There exists unique cutoffs in the value promised, V, $\underline{v}$ and $\overline{v}$, with $\underline{v} < \hat{V} < \overline{v}$, such that :*

— *the worker obtains a **temporary** contract **and** a wage $w_T(V) < \underline{w}_P$, for $V < \underline{v}$;*

— *the worker obtains a **permanent** contract **and** a wage $w_P(V) > \overline{w}_T$, for $V > \overline{v}$.*

This result is the consequence of the fact that $w_P(V)$ and $w_T(V)$ are continuous and strictly increasing in V, as it is illustrated in figure 1.5. This figure represents the wage associated with the optimal contract, conditional on the value promised to the worker. The figure also represents the threshold $\hat{V}$, which guides the contract choice (proposition 2), along with the values $\underline{v}$ and $\overline{v}$, which are mentioned in the above proposition.

Figure 1.5 – The wage and the contract type as a function of the value promised to the worker.



Thus, the last proposition emphasizes a mechanism which tends to increase the relative wage of permanent workers. It states that a worker signing a contract promising a *low* value obtains a temporary contract *and* is paid a *low* wage. In particular, this wage would be lower than any wage that would be paid to a worker obtaining a permanent contract. At the opposite, the worker with a *high* value promised obtains a permanent contract *and* a *high* wage, which is higher than any wage received by a temporary worker. This ranking is not perfect though, as in the neighborhood of $\hat{V}$, i.e. in the interval $[\underline{v}, \overline{v}]$, the wage values associated with the two types of jobs overlap.

In a labor market equilibrium model, the correlation between the job type and the wage will depend on the mechanisms shaping the distribution of the surplus. In a model with Nash Bargaining, the wage and the probability of obtaining a permanent job would presumably be a positive function of the worker's bargaining power. [26] In a wage posting environment, the relationship between the job type and the wage will be determined by the distribution of offers. According to proposition 1.5, firms located in the higher part of the value promised distribution will offer permanent jobs with high wages and those located in the lower part will offer temporary jobs with low wages. Consistently with the data, this would tend to generate a wage gap in favor of permanent workers, even among ex-ante identical agents. [27] Because of the fact that the ranking is not perfect, as explained in proposition 4 I would expect that such a model generate an overlap between wage distributions in the two types of jobs.

1.5 Discussion

This section examines the implications of some of the main assumptions on which the analysis is based and discusses some possible extensions of the model.

Insurance with severance pay

It is worth noting that the result on the contract choice relies on the assumption that the employer has no access to severance payments. In theory, the firm can write a contract that specifies a transfer that fully replaces the worker's wage after a layoff. Hence, the severance pay can be substituted for the provision of insurance through the retention

26. However, the effect of bargaining power on the contract choice is not straightforward : a high bargaining power increases the expected value of search and the value of unemployment, thus reducing the demand for job security.

27. This outcome would be related to the results in Pinheiro and Visschers (2015), showing that a wage posting model with heterogeneous firms can generate a positive correlation between wages and job security. In our case, this correlation will obtain from the distribution of risk among agents, which is endogenous to the dynamic contract.

of the match, and the firm can provide insurance to the worker without having to pay the cost of retention. In such a case, the firing cost and the permanent contract become worthless. [28] However, it is reasonable to consider that there exists a set of frictions that prevent full insurance using severance payments. [29] Moreover, assuming that employers do not rely on severance pay for the provision of insurance is empirically relevant. [30] However, some work could be done to analyze further the role of legal firing restrictions in a dynamic environment where employers or the government have access to different instruments for insuring workers.

Savings and worker self-insurance

It is assumed that the worker can not save and consume his entire income at each period. This implies that the insurance is provided to the worker through the employment contract exclusively. Relaxing this assumption would make the worker able to self-insure against income losses due to the shocks on the match productivity through precautionary saving, in addition to the insurance provided by the firm. However, it is worth noting that this would not affect qualitatively the result of the contract choice of proposition 2. In presence of market incompleteness, the worker would not be able to fully self-insure and would still value the insurance provided by the firm. Because of the concavity of his indirect utility with respect to income, the worker would be willing to trade a fraction of the wage for a higher degree of job security. Hence, the lemma 4 stating that the employer

28. However, the worker can value job stability if this is associated with an increasing wage profile, as for instance, in models where the worker climbs the job ladder as his uninterrupted work experience increases (e.g. Burdett and Mortensen (1998), Postel-Vinay and Robin (2002),Burdett and Coles (2003), Shi (2009), Lentz (2014)). Indeed, recent research highlights the link between job security and wage growth (e.g. Burdett et al. (2015), Jarosch (2015)).

29. For instance, in presence of moral hazard, the workers might have an incentive shirk in order to trigger separation and going back to unemployment with the severance payment. In the case where the employer can monitor effort in a continuing job the cost of insurance associated with the retention of the match might be lower. Moreover the employer might have an incentive to renege ex-post on a contract promising generous a severance payments. Hence, such contract might be difficult to enforce. For instance, if the agents' behavior is imperfectly observed, the employer can claim that the dismissal is due to a fault from the worker.

30. In the US, as emphasized by Rudanko (2011) and according to Chetty (2008), only 19 percent of workers receive SP, which suggests that employers do not generally rely on it to provide insurance. In the same time, we have evidence that employers insulate their workers' wages from temporary productivity shocks (for instance Guiso et al. (2005), Lamadon (2016)). Moreover, Alvarez and Veracierto (2001) argue that the effect on employment and welfare of the firing penalty component of mandated severance payments is more important than its transfer component. This is in line with my mechanism, which emphasizes the importance of the firing cost but neglects the role of severance payments.

pays a wage differential and, therefore, the proposition 2 about the contract choice is expected to hold in presence of savings. [31]

The absence of savings is relatively innocuous for the results in the first chapter, which are of a qualitative nature. However, this assumption has some quantitative implications which are relevant to the results of chapter 2. Indeed, allowing the worker to save will presumably increase the cutoff in the value promised such that the permanent contract is chosen, $\hat{V}$. Indeed, self-insurance can contribute to smooth consumption after a job loss, which decreases the cost of unemployment and, therefore, the wage differential. Therefore, ignoring savings might lead to overstating the willingness of agents to form permanent contracts. Notice, however, that the models of chapter 1 and 2 are mainly intended to examine what determines the transitions of workers in and out of unemployment. Presumably, low asset workers are over-represented among those who are the most exposed to these transitions. Assuming that these workers are hand-to-mouth is a reasonable approximation, which does not affect so much the model dynamics. It is true however that a model combining long-term contracting with wealth accumulation might help to gain a better understanding about the link between employment protection and consumption risk. [32]

On-the-job search

I assume that workers cannot search on-the-job. As suggested by Postel-Vinay and Turon (2014), omitting on-the-job search may conduct to overestimate the negative effect of employment protection. [33] This is also the case in this chapter, because allowing the

31. Observe, however, that the wage dynamics delivered by the optimal contract might be affected. Indeed, as suggested by Ábrahám and Laczó (2017), in presence of saving, the worker's outside option will be a function of his asset. If the worker's reservation wage increases with his wealth as well, as it would be the case for instance in a wage-posting environment, then the wage payment will increase with tenure in some situations, as opposed to the contract presented in lemma 1, in which wage cuts are sufficient to preserve the match.

32. Several papers have analyzed the effect of employment protection in environments with incomplete markets and savings (Alvarez and Veracierto (2001), Krebs (2003), Lalé (2018),...), but to the best of my knowledge, there is no work which combines long-term contracting and wealth accumulation. Notice that the papers which analyze dynamic risk-sharing contracts in frictional labor markets (Rudanko (2011),Lamadon (2016),...) have, to my knowledge, ignored savings as well. Combining elements from these two strands of the literature is probably a technical challenge but it might be interesting to evaluate the role of the policy for the distribution of consumption risk.

33. Postel-Vinay and Turon (2014) argue that employers can use severance payment to incentivizes workers in low productive matches to reallocate to new matches or to leave to unemployment.

worker to quit would lower the cost of retention of an unproductive match. [34] However, as it is the case with savings, omitting on-the-job search does not affect qualitatively the result on the contract choice. [35] Indeed, the employer constraint would be still affected by the firing costs and he would still face a trade-off between risk-sharing and flexibility when choosing the contract.

But allowing workers to search on-the-job will have important implications for the outcome of an equilibrium model. Indeed, this will affect the sorting of agents into the two types of jobs in particular because, as stated in proposition 2, the value of the contract is a key determinant for the contract choice. In such an environment, the sorting would be endogenous to the competition taking place between the employers. As suggested in proposition 4, the firms would use the wage jointly with the provision of job security (through the contract type) to attract or retain the workers. Hence, including on-the-job search would be probably important for understanding the link between employment protection, wages and job security. But these important questions are beyond the scope of chapters 1 and 2, which focus more on the analysis of labor market transitions between unemployment and employment. [36] Moreover, allowing the worker to search on-the-job complicates the design of the contract in a way which is detrimental to the analytical (in this chapter) and computational (in chapter 2) tractability of the model and, more importantly, to the clarity of the results. This assumption allows putting more emphasis

34. This would especially true in presence of unobservable search effort in which the employer might be induced to frontload the wage during bad times in order to incentivize the worker to search for a new match (Lamadon, 2016). Moreover, omitting on-the-job search conducts to understate the benefits of firing costs. On-the-job search increases the probability of the destruction of a match and, therefore, reduces the employer's discount factor. As a result, the willingness of an employer to retain a match or to keep the wage constant during bad times might be higher (i.e. the threshold for separation in the permanent contract $\underline{z}_P$ and the threshold for wage cut might be lower) : lowering the discount factor lowers the expected cost of retention for the ongoing period. Therefore, in this context, the commitment effect associated with the firing costs might be higher.

35. The design of the contract conditional on the firing cost would be different though, because searching on-the-job search will allow the worker to improve his outside option and, therefore, to obtain wage increases. Moreover, as discussed above, if search effort is unobservable, the employer will backload (frontload) the wage when the profits are positive (negative) in order to influence efficiently the worker's incentives to search (Shi (2009), Lentz (2014), Lamadon (2016),...)

36. As reported by Cahuc et al. (2016a), the majority of temporary jobs created in France and Spain during the 2000s have very short duration, lower than one month. In these types of jobs, which are likely to account for an important part of the transitions between unemployment and employment, employer-to-employer transitions have presumably little relevance. However, on-the-job search might be important to account for the transitions between temporary and permanent jobs for workers with a few months of tenure or more.

on the trade-off between risk-sharing and flexibility which is behind the contract choice and which is the central mechanism for the results presented in the two first chapters.

1.6 Conclusion

This chapter analyzes a dynamic contracting problem between a worker and a firm in order to understand how they choose between a permanent contract with high firing costs and a temporary contract without firing costs. The choice between the contract is driven by a trade-off between the gain of commitment to job stability and the gain of the flexibility of separation. The value promised to the worker is a key determinant of the choice between the contracts. An increase in the worker's surplus increases the attractiveness of the permanent contract. This analysis is conducted in a partial equilibrium setting. In chapter 2, I will nest this contracting problem in a model of the labor market to analyze the macroeconomic effect of temporary jobs and firing costs.

Chapitre 2

Risk Sharing in a Dual Labor Market

2.1 Introduction

This chapter presents a model of the labor market based on the dynamic contracting problem of chapter 1. The aim of this chapter is to assess the macroeconomic consequences of the dual employment protection system that prevails in several countries, which is characterized by the coexistence of temporary, fixed-term jobs and permanent, open-ended jobs with strict firing restrictions. What is the effect of a dual employment protection system on the unemployment rate and aggregate output ? How do temporary jobs and firing costs affect firm productivity and worker well-being ? The model presented in this chapter allows me to address these questions.

Using the risk-sharing problem of chapter 1, I propose a model of a frictional labor market in which the sorting of workers and firms into permanent and temporary jobs is endogenous. In equilibrium, temporary jobs coexist with permanent jobs for two reasons. First, temporary contracts provide the employer with higher flexibility and increase their willingness to form low productivity matches which would otherwise be unprofitable under a permanent contract. This effect is associated with gross job creation. Second, employers can offer a temporary contract when a permanent contract would have been feasible. This effect implies the substitution of temporary for permanent jobs, which exposes a fraction of the labor force to a higher risk of unemployment, and results in an increase in gross job destruction. These two channels have opposite effects on the stock of employment and aggregate output.

To quantify the net effect of temporary contracts, I calibrate the model to represent the French labor market, characterized by a sharp divide between temporary and permanent jobs. I perform a set of counterfactual policy experiments, in which I increase the hiring restrictions on temporary contracts. The quantitative results indicate that tightening the regulation in order to match the employment share of temporary jobs observed in France at the beginning of the 1980s *reduces* employment by almost one percentage point but raises productivity by 1.7% and output by 0.7%. This suggests that allowing employers to use temporary contracts lowers employment but increases output. I find that temporary jobs substitute for an important fraction of permanent jobs. This substitution effect increases job destruction in the economy and results in net losses in employment. However, temporary jobs raise productivity, by facilitating the reallocation of labor inputs from low to high productivity matches. These productivity gains generate higher output, despite the fall in the employment rate. I also find that temporary contracts are associated with higher welfare among workers. Indeed, the presence of temporary jobs which increases the demand for workers raises the value of unemployment. This improves the workers' outside option and their bargaining position, resulting in gains in welfare.

I also evaluate the effect of a reduction in the strictness of firing restrictions on permanent jobs. A suppression of the firing cost *increases* unemployment and output, by one percentage point and 0.7%, respectively. Reducing the firing cost increases the separation rate of low productivity jobs, resulting in net losses in employment and net gains in total output. Finally, I find that the firing cost slightly increases welfare among employed *and* unemployed workers. Under limited commitment, the presence of firing increases the surplus associated with some of the high productivity matches. Consequently, the expected value of search of a non-employed worker increases ; this slightly improves the value of unemployment.

This chapter is organized as follows. Section 2 describes the model. In section 3, I present the quantitative results, and I conclude in section 4.

2.2 Model

The model is built from the contracting problem of chapter 1. This contracting problem is nested in an equilibrium model of the labor market with endogenous transitions between unemployment, temporary and permanent employment. The model is presented in the following subsection.

2.2.1 Environment

Agents

Time is discrete with an infinite horizon and is indexed by t. The economy is populated with risk neutral employers and risk-averse workers. The population of workers is constant and normalized to one. Agents have a discount factor β. The preferences of workers are represented by the utility function $u(c_t)$, where c_t is consumption at time t. The utility function is strictly increasing, strictly concave and twice continuously differentiable. Workers cannot save, and they consume their entire income at each period.

Production

Employers have access to a linear production technology which uses labor as the sole input. Each time period, workers are endowed with one indivisible unit of labor. To produce, a worker and an employer have to be paired together in a match. The productivity of a match is a random variable. The output of a match at time t is given by

$$y_t = z_t \cdot x$$

where $x > 0$ is the permanent component of productivity and z_t is a stochastic component. The permanent productivity term captures the specific quality of a match is fully known. As opposed to chapter 1 in which the stochastic term evolves on a continuum and shocks were iid, I assume that z has support $Z = \{z_0, z_1\}$, and that these shocks are driven by a first-order Markov process. I set $z_0 < z_1$: the state z_1 is referred as the *high productivity* state and z_0 is the *low productivity* state. The stochastic variable has transition probability

$\pi(z'|z) > 0$ for any $z, z' \in Z$ and it is assumed that $\pi(z_1|z_1) > \pi(z_1|z_0)$ to ensure that profit function is monotonically increasing in z. The term x represents the match quality that is constant over the duration of an employment relationship. [1] Exogenous separations occur with probability δ.

Contract and legislation

Permanent and temporary contracts

As in chapter 1, the employer and the worker sign a long-term contract, σ_c, for $c \in \{P, T\}$ that specifies a set of layoff rules and wage sequence contingent on the possible histories of z. Commitment is limited : the contract should deliver to the agents a value higher than their outside option at any point of time ; separation occurs in states such that there exists no wage sequence that satisfies jointly the worker's and the employer's participation constraints. Moreover, at the beginning of the contract, the worker and the firm bargain over the contract value, V. This value should be provided to the worker at the beginning of the contract according to the keeping promised constraint.

Two types of contracts are available. The **permanent contract** (PC), denoted by σ_P has firing costs $F_P = F > 0$, paid by the employer. The **temporary contract** (TC), denoted by σ_T has zero firing costs. [2] Given the presence of these two different contracts, the employer's problem consists in two steps. First, he chooses between the permanent and the temporary contract, given the value promised to the worker. Second, the employer sets the layoff rule and the wage policy conditional on the initial contract choice. I assume that the employer is always free to convert the temporary contract into a permanent contract, but that the

1. As explained thereafter, the match quality will be heterogeneous across matches. This heterogeneity will be a key driver of the sorting of agents into permanent and temporary jobs at the equilibrium.

2. Assuming a zero firing cost for the temporary contract is a simplification, which is common in the literature on dual labor markets. However, as it is explained in Cahuc et al. (2016b), it is often more costly to terminate a temporary contract before its term than a permanent contract in several European countries. Indeed, the French legislation, for instance, an early termination of a TC initiated by the employer is allowed only in cases of serious misconduct or force majeure (Auzero and Dockès, 2016). But still, when employers have sufficient information about the distribution of the future realizations of productivity and demand, they can modulate the duration of a temporary job in order to minimize output losses due to a negative shock. The crucial distinction that I try to capture here is that temporary contracts provide more flexibility to employers and presents a higher risk of unemployment than the permanent contract. Introducing a difference in firing costs is sufficient to capture these key aspects. Moreover, the temporary contract as it is modeled in this work, can be interpreted as a sequence of succesive state-contingent fixed term contract that are renewed or terminated depending on the realization of the productivity shock.

converse is not possible. [3] As in chapter 1, I assume that there are no severance payments. The firing cost is a penalty paid by the employer after a layoff.

The Regulation on temporary contracts

The use of temporary contracts is regulated. The model includes two aspects of the legislation. First, temporary contracts have a maximum duration, which is determined by the law. Second, the employer is not always allowed to propose to a worker a temporary contract. The regulation specifies the conditions under which a temporary contract can be formed. These regulations do not affect the sorting behavior in the model in a qualitative way but are needed to capture the aspects of the French labor market.

Temporary contracts have a maximum duration. [4] When the maximum duration is reached, the employer is bound to convert the temporary job to a permanent position, if he is willing to continue the employment relationship. Otherwise, the employer and the worker separate. The regulation on the maximum duration is captured by the parameter $\phi \in [0,1]$, which is the probability that a contract ends in a given period. With probability ϕ, the employer is obliged to propose a permanent contract or to separate. Then, I assume that the employer and the worker bargain on a promised value V_t and sign a new contract. The temporary contract has a stochastic duration, so there is no need to keep track of worker's tenure.

The model environment also includes hiring restrictions on temporary contracts. In many countries, the legislation considers permanent jobs as the normal form of employment and temporary contracts are intended to be used only for specific reasons (replacement of a regular employee, adjustment to temporary workload fluctuations,...). [5] In the model, the parameter $\phi_0 \in [0,1]$ captures the intensity of hiring restrictions on

3. This assumption is consistent with the regulation prevailing in many European economies, in which a permanent contract cannot be converted in a temporary contract.

4. In the case of France, that will be considered for the quantitative part of the paper the maximum legal duration of a temporary contract is generally between 18 and 24 months. The contract can be renewed twice, but the total time spent by a worker in a temporary position cannot exceed the maximum duration.

5. In the case of France those reasons are : temporary replacement of a regular employee who is absent from work, adjustment to temporary workload fluctuations, seasonal work. In several industries however, where there are high needs in flexibility, the regulation is less strict (for instance : catering, entertainment industry, teaching,...). Moreover, if the worker considers that the conditions have not been fulfilled by the employer, he can go to the labor court in order to ask for a conversion of his contract to a permanent contract (Auzero and Dockès, 2016).

temporary jobs. [6] I will use the parameter ϕ_0 to capture the set of hiring restrictions on TC. As for the legislation on the maximum duration, these restrictions are formalized in a stochastic manner. Upon a meeting between a worker and an employer, the restriction on TC will be binding with probability ϕ_0, in which case the employer is only allowed to hire the worker in a permanent position. Otherwise, with probability $1 - \phi_0$, the employer can freely choose between both types of jobs. Hence, at the equilibrium, the parameter ϕ_0 will be the share of new matches allowed to freely choose between a PC and a TC. A high value of ϕ_0 indicates a tight regulation, and a value $\phi_0 = 0$ means a total absence of restrictions on temporary jobs. Given the main question of interest in this work, which is to understand the effect of temporary contracts on labor market outcomes, this parameter will have a key role in the counterfactual policy experiments that I will conduct in the quantitative part of the paper.

The labor market

The labor market is affected by search frictions. Search is random. Unemployed workers search for jobs and firms post vacant jobs and search for workers. [7] An unemployed worker receives an income b at each period which is independent of his type. To post a vacancy, a firm pays a cost κ at each period. The mass of job seekers is denoted by u. The mass of vacancies is denoted by v, and the tightness of the market is given by $\theta = v/u$. The probability, for a worker to meet an employer is given by $\lambda_0(\theta)$, which is a strictly increasing and concave function of the tightness. For a firm, the probability of meeting a worker is given by $q(\theta)$, which is a strictly decreasing, concave of θ. Matching is stochastic : the quality of matches, given by x, is a random variable, drawn in a cdf $G(x)$. Upon meeting in the labor market, a worker and a firm discover the productivity of their potential match.

6. In the benchmark calibration, I will set $\phi_0 = 0$. This choice is motivating by the fact that TC account for about 90% of job creation in France ; this suggests that the enforcement of the hiring restrictions on TC is low (Cahuc et al., 2016b). This parameter will be useful in the quantitative part of the paper, in which I will conduct a set of counterfactual experiments consisting in increasing the intensity of these restrictions.

7. Alternatively, we could analyze an environment with competitive search (Moen, 1997). The first reason for favoring random search is technical. Indeed, it is not straightforward to introduce competitive search because the choice between the two contract implies that the objective functions of agents searching for a match is not concave, unless lotteries on the contract type are introduced. The second reason is related to the fact that I consider a environment with stochastic match quality. As I will detail below, in equilibrium, the match quality is a key variable for the contract choice and the sorting of agents ; however, the ability of firms to commit to a contract value before observing the match quality is limited.

Accordingly, they decide whether to start or not an employment relationship and to sign a contract. I assume that all matches start in the high productivity regime, in which $z = z_1$.

At the beginning of a match, the worker and the employer bargain over the value promised to the worker V. Given the value V and the quality of the match, x, the employer chooses between a permanent and a temporary job and designs the optimal contract. The choice between the contracts is analyzed in the following subsection.

2.2.2 Employer's problem

The employer's problem can be written as

$$J_c(V,z) = \max_{\sigma_c \in \Gamma(V,z)} zx - w + \beta(1-\delta)\sum_{z' \notin S} \pi(z'|z) J(V(z'), z') - \beta(1-\delta)\Pr(z' \in S|z) F_c \tag{2.1}$$

subject to the following set of constraints :

$$\Gamma_c(V,z) = \Bigg\{ \sigma_c |$$

$$u(w) + \beta(1-\delta)\sum_{z' \notin S} \pi(z'|z) V(z') + \beta\Big[\delta + (1-\delta)\Pr(z' \in S\,|z)\Big] U \geq V \tag{2.2}$$

$$V_c(z') \geq U \text{ for } z' \notin S \tag{2.3}$$

$$J_c(z') \geq -F_c \text{ for } z' \notin S \Bigg\} \tag{2.4}$$

given value promised V and productivity z. The employer chooses the contract type that maximizes his profits conditional on V following :

$$J(V,z) = \max\{J_P(V,z), J_T(V,z)\}. \tag{2.5}$$

The following subsection analyzes the design of the optimal contract and the choice between a permanent and a temporary job.

2.2.3 Optimal contract

For clarity, I assume in this section that $\phi = 0$, which means that there is no limit on the duration of a temporary contract. [8] The design of the optimal contract of type c, for a starting match with productivity $z' = z_1$ is characterized by the following lemma.

Lemma 5. *In the optimal contract of type $c \in \{P, T\}$, in a match with state (V, x, z) and associated wage $w_c(V, x, z)$:*

— *the probability of separation is given by*

$$\delta + \mathbb{I}\Big[\underline{w} \leq \overline{w}(x, z_0)\Big](1-\delta)\pi(z_0|z_1)$$

where $\underline{w}$ is the reservation wage ;

— *For $\overline{w}(x, z_0) > \underline{w}$, the wage evolves following*

$$w_c(V(z'), x, z') = \begin{cases} w_c(V, x, z_1) & \text{if } z' = z_1 \\ \min\Big\{w_c(V, x, z_1), \overline{w}(z_0)\Big\} & \text{if } z' = z_0 \end{cases}$$

where $\overline{w}(x, z_0)$ solves the employer's constraint with equality in the low productivity state.

As in chapter 1, the optimal contracts prescribes a constant wage, unless the employer constraint is binding in the low productivity state. In this case, the worker is paid the wage $\overline{w}(z_0, x)$. When the reservation wage is below this wage, that means that there is exists no wage such that both participation constraints are jointly satisfied. The probability of wage cut and separation is a decreasing function of the firing cost and a decreasing function of the match productivity. In the following proposition, I use this characterization of the optimal contract to analyze the choice between a permanent and a temporary job depending on the productivity of the match and the value promised to the worker.

Proposition 5. *There exist unique x_P^s and $\hat{V}$ such that the employer chooses a permanent contract when $x \geq x_P^s$ and $V \geq \hat{V}$. Otherwise, a temporary contract is preferred.*

8. Qualitatively, the result is unchanged with this assumption. However, the choice of the parameter ϕ_0 will have quantitative implications because it will affect profit associated with a temporary contract. Moreover, it will matter for the calibration of the model, especially to match properly the transition rate from temporary to permanent jobs and the employment share of temporary jobs in the French economy.

Proof. I solve for the value of the employer associated with the value of unemployment, in the low productivity state, z_0, which writes as

$$J_c(U, z_0) = (1 - \beta(1-\delta))^{-1} \left\{ K(z_0) x - \underline{w} \right\}$$

with

$$K(z_0) = \frac{z_0 + \beta(1-\delta)[\pi(z_1|z_0)z_1 - \pi(z_1|z_1)z_0]}{1 + \beta(1-\delta)[\pi(z_1|z_0) - \pi(z_1|z_1)]}$$

Separation occurs in the low productivity state when $J_c(U, z_0) < -F_c$. Hence, the threshold in x, that I denote x_c^s, such that the state z_0 in contract c is associated with separation satisfies

$$x_c^s = \frac{(1-\beta(1-\delta))F_c + \underline{w}}{K(z_0)}$$

For $x < x_P^s \equiv \tilde{x}$, where x_P^s is the threshold associated with separation in the bad state for a permanent contract, the temporary contract is always preferred. Indeed, in this case, the firing cost has no insurance role and represents a pure loss for the match. So the temporary contract is always strictly preferred for $x < x_P^s \equiv \tilde{x}$.

For $x_p^s \leq x < x_T^s$, the choice between contracts depends on the worker value. Indeed, in this interval, separation occurs in the temporary contract but not in the permanent contract. The match is kept during the bad productivity shock, and the value of the worker is adjusted depending on the participation constraint of the employer. However, in this interval, the employer's value is negative during the bad productivity shock. This incurs a cost for the employer, which is the cost of providing insurance through the retention of the match.

In the case such that $x_p^s \leq x < x_T^s$, the worker faces a higher risk of unemployment in the TC than in the PC. This difference in the risk is reflected in the wage differential paid to the worker to make him indifferent between the two types of jobs, which is $\Delta w(V) \equiv w_T(V, z_1) - w_P(V, z_0)$. Indeed, the wage in the TC written as a function of the worker surplus is given by

$$w_T(V, z_1) = u^{-1}\Big\{(1-\beta(1-\delta)\pi(z_1|z_1))(V-U) + (1-\beta)U\Big\},$$

and the wage in the PC satisfies

$$w_P(V, z_1) = \begin{cases} u^{-1}\Big\{(1-\beta(1-\delta))(V-U) + (1-\beta)U\Big\} & \text{if } V \leq \overline{V}(z_0) \\ u^{-1}\Big\{(1-\beta(1-\delta)\pi(z_1|z_1))(V-U) - \beta(1-\delta)\pi(z_0|z_1)(\overline{V}(z_0) - U) + (1-\beta)U\Big\} & \text{if } V > \overline{V}(z_0) \end{cases}$$

where $\overline{V}(z_0)$ is the value such that the employer's participation constraint is binding in the low productivity state, given by

$$\begin{cases} \overline{V}(z_0) = \dfrac{u(\overline{w}(z_1)) + \beta\delta U}{1-\beta(1-\delta)} \\ w = K(z_0)x_s + (1-\beta(1-\delta))F. \end{cases}$$

and the wage differential is strictly positive in $[x_p^s, x_T^s)$, since we have that $\overline{V}(z_0) > U$, due to the fact that the employer is able to promise to the permanent worker continuation of the match during the low productivity state. The derivative of the wage differential with respect to V is

$$\partial(\Delta w(V, z_1))/\partial V = \begin{cases} \dfrac{1-\beta(1-\delta)\pi(z_1|z_1)}{u'(w_T(V, z_1))} - \dfrac{1-\beta(1-\delta)}{u'(w_P(V, z_1))} & \text{if } V < \overline{V}(z_0) \\ \Big[1-\beta(1-\delta)\pi(z_1|z_1)\Big]\left\{\dfrac{1}{u'(w_T(V, z_1))} - \dfrac{1}{u'(w_P(V, z_1))}\right\} & \text{if } V \geq \overline{V}(z_0) \end{cases}$$

which is strictly positive since $u'(w_T) < u'(w_P)$ since $w_P < w_T$. The derivative of the wage differential increases with V because the marginal cost of providing V to the worker increases faster in the TC than in the PC. Now, compute the function $\Delta J(V,z_1) \equiv J_P(V,z_1) - J_T(V,z_1)$, which is the difference in profits obtained by the employer in both contracts, which can be written as

$$\Delta J(V,z_1) =$$
$$\left[1-\beta(1-\delta)\pi(z_1|z_1)\right]^{-1}\left\{\underbrace{-(w_P(V)-w_T(V))}_{\text{Wage differential}}+\underbrace{\beta(1-\delta)\pi(z_0|z_1)J_P(V(z_0),z_0)}_{\text{Cost of retention}}\right\}$$

The function can be decomposed in two terms. The first term is the wage differential, that we analyzed above. The second term is the cost of retention, which constitutes the cost of insuring the worker against the bad state, through the provision of job security. This term is given by the expression

$$J_P(V(z_0),z_0) =$$
$$\max\left\{-\frac{\left[1+\beta(1-\delta)\pi(z_1|z_1)\right]w_P(v)-\beta(1-\delta)\pi(z_1|z_0)(x-w_P(v))}{(1-\beta(1-\delta))(1+\beta(1-\delta)(\pi(z_1|z_0)-\pi(z_1|z_1)))},-F\right\}$$
$$< 0 \text{ for } x \in (x_s^P, x_s^T)$$

How do those terms change with V? First, observe that when $V = U$, we have that $\Delta w(U,z_1) = 0$. When the worker receives his reservation value, he is indifferent between staying matched and being laid-off. In this case, the wage differential is zero. But still, we have that $-F \leq J(U,z_0) \leq 0$ in the interval considered, ie. the cost of retention is positive in $x \in (x_s^p, x_s^T)$. So, $\Delta J(V,z_1) < 0$, for V close to U.

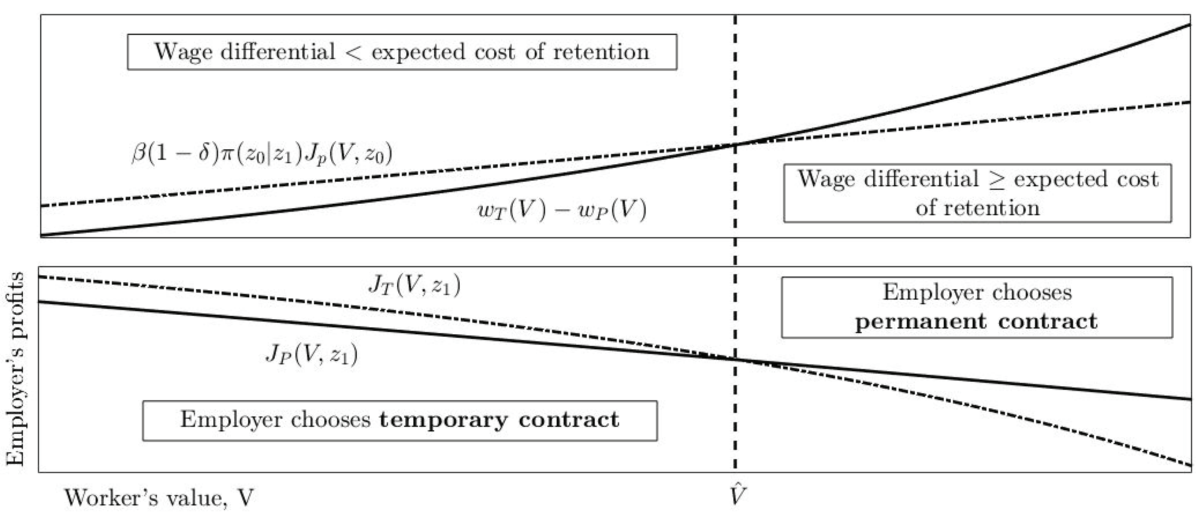
Now, compute the derivative of the term associated with the cost of retention of the match. The derivative of this term is given by

$$\partial J_P(V(z_0),z_0)/\partial V = \begin{cases} -\dfrac{1}{u'(w_p(V))} & \text{for } V \leq \overline{V}(z_0) \\ 0 & \text{for } V > \overline{V}(z_0) \end{cases}$$

Then, we have that $\partial(\Delta J)/\partial V > 0$, because the wage differential increases faster than the cost of retention with V. Since the utility function is continuously differentiable, there exists a point $V = \hat{V}$ such that $\Delta J = 0$, with $\Delta J(V) < 0$ for $V < \hat{V}$ and with $\Delta J(V) \geq 0$ for $V \geq \hat{V}$. The temporary contract is preferred in the interval $[U, \hat{V})$ and the permanent contract is preferred for $V \geq \hat{V}$. □

In figure 2.1, I illustrate the trade-off underlying the choice between the permanent and the temporary contract. The figure above plots the wage differential and the term measuring the cost of retention, as functions of V. The picture below represents the Pareto-frontier associated with each type of contract, that is determined by the wage differential relative to the cost of retention. For $V \leq \hat{V}$, the PC is associated with efficiency gain compared to the TC.

Figure 2.1 – The choice between the permanent and the temporary contract in the two state case



In the case where $x > x_T^s$, the cost of retention is zero. Indeed, for such a high level of productivity, the match continues to generate a positive surplus during the bad state. Then, the firing cost only plays the role of a commitment device, and it increases unambiguously the surplus of the match. Then, the employer weakly prefers the permanent contract, for all value of V. In this case, we have that $\hat{V} = U$. □

2.2.4 Labor market equilibrium

The contracting problem is nested in a model of the labor market with search frictions. This subsection describes the steady-state equilibrium of the labor market.

Hiring and surplus sharing

So far, we have analyzed the contracting problem by taking as given the value V which is transferred to the worker. This value depends on how the surplus is shared between the worker and the employer at the beginning of a match. First, define the value $\overline{V}_c(x)$, which is the employer's willingness to pay for a match with productivity x in a contract of type c. This is the value such that $J_c(\overline{V}, x, z_1) = 0$, ie such that the employer's profit is zero for this match in job c. Define also the value $\overline{V}(x) \equiv \max\left(\overline{V}_P(x), \overline{V}_T\right)$ as the willingness to pay of an employer for a worker in a match with productivity x, given that he can choose freely between both contracts.

Given the productivity of a potential match, and given the regulation, how the hiring decision is taken? In the case where the regulation does not bind, which occurs with probability $1 - \phi_0$, a match between an employer and a worker is formed under the condition that $\overline{V}(x) \geq U$. When the regulation binds, which is the case with probability ϕ_0, the match is formed under the condition that $\overline{V}_P(x) \geq U$. In this case, the contract is formed only if the employer is willing to pay for a permanent contract.

Now, it remains to understand how the surplus of a match is shared between a worker and a firm. The surplus obtained by the worker depends on the regulation also. I assume that when the regulation is not binding, the worker obtains a share of the surplus $\alpha\overline{V}(x) + (1-\alpha)U$, under the condition that $\overline{V}(x) \geq U$, where $\alpha \in [0,1]$ is a parameter capturing the worker bargaining power. When the regulation binds, and the employer has only access to the permanent contract, the worker obtains $\alpha\overline{V}_P(x) + (1-\alpha)U$, under the condition that $\overline{V}_P(x) \geq U$.

To sum up, a worker meeting an employer obtains a value denoted by $\tilde{V}(x)$ and given by

$$\tilde{V}(x) - U = \alpha \left\{ (1-\phi_0)\max(\overline{V}(x), 0) + \phi_0 \max(\overline{V}_P(x), 0) \right\}, \tag{2.6}$$

which expresses the surplus received by the worker upon meeting an employer endowed with a match with productivity x. This value reflects the bargaining power of the worker, captured by the parameter α, and the presence of the regulation on hirings.

The parameter α determines the value V, which affects the design of the optimal contract. This value determines the level of the wage and its evolution over time. [9] As we have seen, V also determines the choice of the contract. Through V, the parameter α affects the flows towards permanent and temporary jobs.

For an employer, I denote by $\tilde{J}(x)$ the value associated with a meeting with a worker, conditional on being endowed in a match with productivity x. This value is given by

$$\tilde{J}(x) = (1-\phi_0)\max(J(\alpha\overline{V}(x) + (1-\alpha)U, x), 0) + \phi_0 \max(J_P(\alpha\overline{V}_P(x) + (1-\alpha)U, x), 0) \tag{2.7}$$

Given the surplus sharing rule (2.6), we can examine now the value of an unemployed worker and the value associated with a vacant job.

Unemployment

We have analyzed the optimal contract (2.1) by taking as given the outside option of the worker, which is formed at the equilibrium of the labor market. Now that we have analyzed the surplus sharing rule, we can analyze the value of unemployment. The value function of an unemployed worker is given by

$$U = u(b) + \beta\lambda(\theta)\int_{x'} \tilde{V}(x')dG(x') + \beta(1-\lambda(\theta))U \tag{2.8}$$

9. V determines the level of the wage through the promise-keeping constraint 2.2, but also its evolution over time. Indeed, the higher is V and thus the wage, the higher is the probability of a wage cut due to the fact that the employer participation constraint is binding.

At each period, an unemployed worker receives an income of b. With probability $\lambda(\theta)$, the worker meets an employer. The quality of the match x is drawn from the cdf $G(x)$, which is used to form the expectation associated with search. Upon meeting an employer endowed with a match of quality x, the worker receives utility $\tilde{V}(x)$, according to (2.6). In the case where $\overline{V}(x, z_k) < U$, ie when the match is not productive enough, the worker stays unemployed. With probability $1 - \lambda_0(\theta)$, the worker does not meet an employer.

Value of a vacant job

We examine now the value associated with a vacant job, given (2.7). The value of maintaining a vacant job is given by

$$J_0 = -\kappa + \beta q(\theta) \int_{x'} \tilde{J}(x') dG(x') + \beta(1 - q(\theta))V \tag{2.9}$$

The value of holding a vacancy and searching for a worker is given by c at each time period. With probability $q(\theta)$, the employer meets a worker and draws a match quality in the cdf $G(x)$. The expectation associated with a meeting is formed accordingly. The probability of a meeting depends on the tightness of the market, $\theta = v/u$, which depends itself on the stock of unemployed workers. To compute u, we need to examine the flows in the labor market.

Labor market flows

Analyzing labor market flows requires to understand how the sorting into different employment states operates at the equilibrium. The following proposition characterizes the transitions from unemployment depending on the quality of a match.

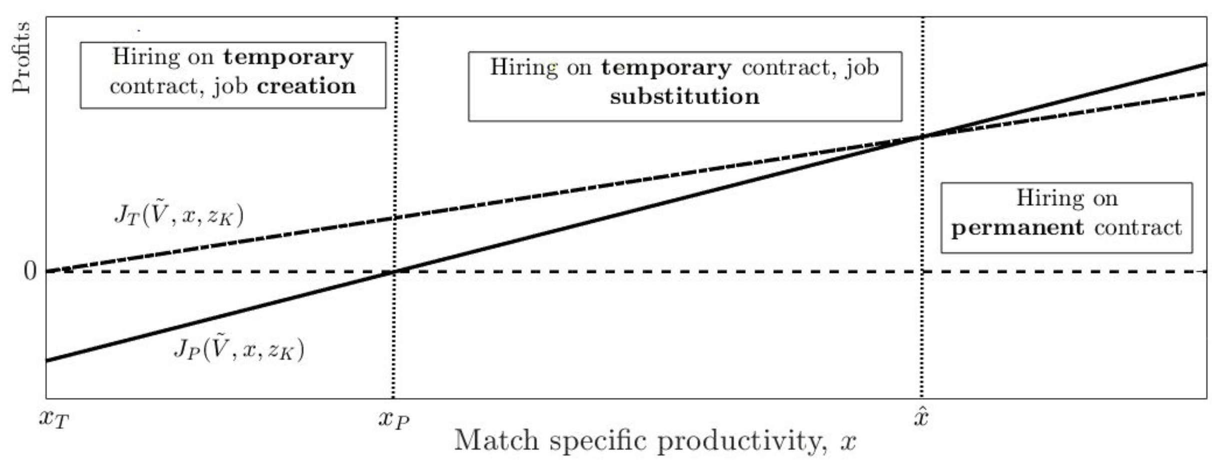
Proposition 6. *There exists a set of thresholds in the quality of matches, x, denoted by $x_T, x_P, \hat{x}$, with $x_T < x_P \leq \hat{x}$, such that, when an employer and a worker meet in the labor market :*

- *If the employer is allowed to choose between the permanent and the temporary contract :*
  - *the worker stays in unemployment when $x < x_T$;*
  - *the worker is hired on a temporary contract when $x_T \leq x < \hat{x}$;*
  - *the worker is hired on a permanent contract when $x \geq \hat{x}$.*
- *If the employer is only allowed to sign a permanent contract :*
  - *the worker stays in unemployment when $x < x_P$;*
  - *the worker is hired on a permanent contract when $x \geq x_P$.*

Proof. See appendix 3.7.1. □

In figure 2.2, I represent these hiring thresholds. The cutoff values x_T and $\hat{x}$ determine the importance of the job creation effect due to the presence of temporary contracts relative to the job substitution effect that lead to the replacement of permanent jobs. In the region $[x_P, \hat{x}]$, hirings are associated with a substitution of temporary for permanent jobs.

Figure 2.2 – Workers sorting into permanent and temporary jobs at the hiring stage



For an unemployed worker, the probability of being hired in a permanent contract in a job with productivity $x' \leq x$ and denoted by $\Lambda_{U,P}(x,\theta)$ is given by

$$\Lambda_{U,P}(x,\theta) = \lambda(\theta)\Big\{(1-\phi_0)\mathbb{I}(x \geq \hat{x})\Big[G(x) - G(\hat{x})\Big] + \phi_0\mathbb{I}(x \geq x_P)\Big[G(x) - G(x_P)\Big]\Big\}$$

The probability of hiring in a temporary contract with match productivity $x' \leq x$ is

$$\Lambda_{U,T}(x,\theta) = \lambda(\theta)(1-\phi_0)\mathbb{I}(x_T \leq x < \hat{x})G(x)$$

The probability of transition from a temporary to a permanent contract conditional on match productivity x is

$$\tau(x) = \phi\,\mathbb{I}(x \geq x_P)$$

We need also to consider the flows out of employment. Those flows are driven by the stochastic productivity term, z, which determines the probability of separation from a given match. The probabilities of separation in a permanent and a temporary contract with productivity x denoted respectively by $s_P(x)$ and $s_T(x)$ satisfy

$$\begin{aligned} s_P(x) &= \delta + (1-\delta)\Pr(z' < z_s^P(x)) \\ s_T(x) &= \delta + (1-\delta)\Big[\phi(1-\tau(x)) + (1-\phi)\Pr(z' < z_s^T(x))\Big] \end{aligned}$$

Now, we can use these elements to examine the worker flows. Workers transit into three states : unemployment, permanent and temporary jobs. Moreover, because of the presence of the stochastic term z, they also transit between the states associated with the set Z. The cumulative density of x associated with permanent jobs and temporary jobs evolves according to

$$\Delta G_P(x) = \Lambda_{U,P}(x)\,u + \int_{x'<x} \tau(x')g_T(x')dx' - \int_{x'<x} s_P(x')g_P(x')dx' \tag{2.10}$$

$$\Delta G_T(x) = \Lambda_{U,T}(x)\,u - \int_{x'<x} s_T(x')g_T(x')dx' \tag{2.11}$$

and the measure associated with temporary and permanent jobs is $n_P = \int_x^{'} g_p(x')dx'$ and $n_T = \int_{x'} g_T(x')dx'$. Finally, the stock of unemployed workers is given by

$$u = 1 - n_P - n_T \tag{2.12}$$

The unemployment rate can be deduced from the values for the stocks of permanent and temporary jobs given that the total labor force is constant and exogenous (and normalized to unity).

Stationary equilibrium

I analyze the stationary equilibrium of the model. At the equilibrium : (i) employers solve the problems (2.1) and (2.5) and design the risk-sharing contract accordingly ; (ii) the value functions U and J_0 satisfy the Bellman equations (2.8) and (2.9) ; (iii) the flows (2.10) for permanent and temporary employment equal zero ; (iv) the stock of unemployed workers satisfies (2.12) ; (v) there is free-entry of firms and the tightness of the market, θ is such that $J_0 = 0$; (vi) the surplus is shared between workers and firms according to the rule (2.6).

2.3 Quantitative analysis

The section proposes a quantitative analysis of the model that aimed to understand the effect of temporary contracts and firing costs on employment, output and welfare. The model is calibrated to match a set of moments describing the French economy in the 2000s. Based on this calibration, I perform different counterfactual policy experiments, in which I increase the intensity of hiring restrictions on temporary jobs and I decrease the level of the firing costs. In what follows, I present the calibration procedure and outcome. Then, I present the policy experiments and the quantitative results.

2.3.1 Calibration

The model is calibrated using a set of moments describing the French labor market in the 2000s. The French economy is a representative case of labor market duality in Europe. The large majority of workers flows in and out employment is associated with short-term contracts : according to Cahuc et al. (2016a), temporary jobs account for more than 80% of entries into employment during the 2000s. Temporary employment is highly prevalent among young and low educated workers (Givord and Wilner, 2015) and moreover, the transition rate from temporary to permanent employment is low in France compared to the other European countries. [10] Thus, labor market duality is a major concern in France (Le Barbanchon and Malherbet, 2013), and several authors advocate for deep labor market reforms aimed at removing the asymmetry of the employment protection legislation (for instance Blanchard and Tirole (2003), Cahuc and Kramarz (2004) and Cahuc (2012)).

In France since the 1980s, several reforms have relaxed the hiring restrictions on temporary jobs. Since then, the share of permanent jobs has steadily decreased. Temporary contracts represented about 5.5% of total dependent employment in the private sector at the beginning of the 1980s ; in the 2000s, it represents more than 12% of total employment (Picart (2014)). Hence, France is an informative case study about the numerous reforms that have removed the restrictions on temporary contracts in Europe since the 1980s.

Calibration procedure

A subset of the parameters is calibrated externally, using values that are standard in the macroeconomic literature. The length of a period is set to one month, with discount factor $\beta = 0.996$. I assume a constant relative risk aversion utility function, with $u(w) = (w^{1-\eta} - 1)/(1-\eta)$ and with coefficient $\eta = 2$. The parameter capturing the workers' bargaining power, is set to $\alpha = 0.5$. The matching function is assumed to be Cobb-Douglas, ie $m(u,v) = Au^{1-\eta}v^{\eta}$, with elasticity with respect to vacancy equal to $\eta = 0.5$. The cost of posting a

10. According to Eichhorst et al. (2016), the yearly transition rate from temporary to permanent jobs is around 10% in France in 2007, while it is around 25% in the European Union during the same period.

vacancy, κ, is normalized to one. This normalization allows me to identify a value for the matching efficiency, A (Shimer, 2005). I compute the model partial equilibrium and calibrate directly λ, which is the contact probability for a worker, which equivalent to calibrate directly the parameter A, for η and κ fixed. These parameters are reported in table 2.2 as *baseline* parameters. Thereafter, I back-out the value of matching efficiency from the calibrated value of κ, which is used in the counterfactual experiments to examine the labor market equilibrium effect of a change in the regulation.

The parameters governing labor market transitions and productivity are determined using the data on the French labor market. The matching efficiency, κ (or equivalently, the job finding rate, λ, conditional on vacancy posting cost c and elasticity η), is set to match a 9.6% unemployment rate. The calibration also uses the quarterly transition rates between unemployment, permanent and temporary jobs, that have been computed by Givord and Wilner (2015), using the French labor force survey. I assume that the stochastic productivity term, z, lies in a set with support with two elements, $z_0 = 0$ and $z_1 = 1$. The probability of a bad productivity shock, π_0, and the probability of exogenous separation δ are chosen jointly to match a quarterly transition rate from temporary jobs to unemployment equal to 15.4% and a transition rate of 0.9% from permanent jobs to unemployment. The parameter governing transitions from the low to the high productivity state, π_1, and thus the expected duration of the negative productivity shock, is chosen to match a quarterly transition rate from temporary to permanent employment equal to 8.8%. The distribution of match productivity is assumed to be normal with mean μ and standard deviation σ. These parameters are chosen to match a share of temporary jobs equal to 12% (Le Barbanchon and Malherbet, 2013) and a wage to output ratio equal to 0.7 (ILO and OECD, 2015).

Table 2.1 – Targeted moments

	Model	Target
Unemployment benefit/wage	0.69	0.67
Firing cost/output	2.97	3
Wage/output	0.91	0.7
Labor market stocks (%)		
Unemployment	9.6	9.6
Share temporary jobs	11.2	12
Quarterly transition rates (%)		
TtoU	15.3	15.4
PtoU	1.5	0.9
TtoP	9.1	8.8

Finally, the parameters describing the institutional environment are calibrated as follows. The value of b is chosen to match an unemployment benefit ratio equal to 0.67 (OECD, 2007). The firing cost is set to be equal to 3 months of output, which is commonly assumed for European economies (Faccini, 2014). The parameter value for the legal duration of a temporary contract, ϕ, is chosen to match an expected duration of 2 years, which is the maximum duration for fixed-term contracts in France. [11] Finally, I set to $\phi_0 = 0$ the parameter capturing the presence of hiring restrictions on temporary jobs. This choice reflects the fact that the enforcement of these restrictions are presumably low in France, given the high importance of temporary contracts in job creation flows in France (Cahuc et al., 2016a). Moreover, the quantitative application is focused on the analysis of policies that have *removed* the restrictions on temporary contracts. The counterfactual experiments will consist in *increasing* the value of this parameter. The parameters describing the institutional environment are reported in table 2.2, along with those related to productivity and labor market transitions.

In table 2.1, I report the statistics generated by the model and the targeted empirical moments. The model fits well the labor market transitions and the stocks of unemployment and temporary jobs. However, the wage to output ratio generated by the model is higher than the one that is observed empirically. In the data, the separation rate from temporary jobs is high ; this transition rate implies that the negative productivity shock is quite

11. With some exceptions : for instance temporary contracts formed with an unemployed worker of 57 years old or more, or with apprentices can have 36 months duration.

TABLE 2.2 – Parameter values

Baseline		
β	Discount factor	0.996
γ	Relative risk aversion	2
α	Worker bargaining power	0.5
η	Elasticity matching function	0.5
Calibrated : labor market transitions and productivity		
μ	Mean productivity	0.99
σ	Standard deviation productivity	0.25
λ	Probability contact with employer	0.13
δ	Probability exogenous separation	0.002
π_0	Probability bad productivity shock	0.054
π_1	Duration bad productivity shock	0.072
$\{z_0, z_1\}$	Productivity low and high state	{0,1}
Calibrated : institutional environment		
b	Unemployment benefit	0.53
F	Firing cost	2.5
ϕ	Legal duration of TC	0.041
ϕ_0	Legal restrictions on hiring in TC	0

persistent. This tends to decrease the share of output earned by employers in the model.

2.3.2 Policy analysis

This subsection presents two different types of policy experiments. First, I *increase* the intensity of the hiring restrictions on temporary contracts. Second, I examine the effect of a *reduction* in the firing cost. In both cases, I analyze the effect of these counterfactual policies on employment, output and workers' welfare.

The effect of temporary contracts

To evaluate the effect of temporary contracts in the calibrated economy, I use the parameter ϕ_0. In the benchmark, this parameter, that captures the intensity of the restrictions on temporary jobs is set to $\phi_0 = 0$, corresponding to a situation in which employers have full discretion over the choice of contract type. I choose different values for ϕ_0 in the interval $[0, 1]$, and I solve, for each of these values, the labor market stationary equilibrium. The case with $\phi_0 = 1$ describes a situation where temporary contracts are completely disallowed.

In what follows, I report graphically the model generated statistics associated with the counterfactual equilibria. In addition, I also report the outcomes associated with a degree of regulation that is consistent with the share of temporary jobs observed in France at the beginning of the 1980s. The goal of this exercise is to mimic the regulation in place in France at this time, in order to evaluate quantitatively the effect of the reforms that have been implemented since the last decades. Hence, I target a share of temporary jobs equal to 5.5%, as reported by Picart (2014) for the year 1982, which implies a value for the parameter ϕ_0 equal to 0.43. The statistics associated with this counterfactual value are reported in table 2.3 under the column labeled *restrictions on TC*.

First, I analyze how the regulation on temporary jobs, captured by the parameter ϕ_0, affects the unemployment rate in the calibrated economy. The effect of ϕ_0 on unemployment is reported in figure 2.3. Tightening the regulation decreases both the job finding rate and the job separation rate, but according to the model, this induces net gains in employment. Hence, this experiment indicates that temporary jobs are associated with a *higher* unemployment rate in France. As indicated in table 2.3, the unemployment rate is almost one percentage point lower in the economy with the 1980s regulation compared to the benchmark. To understand this result, I look at the effect of ϕ_0 on the composition of employment. Figure 2.4 indicates that decreasing ϕ_0 induces a substitution of temporary for permanent jobs. This substitution effect is quantitatively more important than the job creation effect associated with temporary jobs. As a consequence, lowering the restrictions increases the rate of separation and thus unemployment.

As reported in table 2.3, increasing the restrictions on temporary contracts tends to *decrease* welfare among unemployed workers, measured in certainty equivalent consumption. As discussed before, a tighter regulation decreases the job finding rate, which makes unemployment more costly. This results in a lower reservation wage, that decreases the rate of separation. This effect, along with the fact that permanent jobs are replaced by temporary jobs, explains why a lax regulation increases unemployment in the model. It is worth noting that welfare also increases among employed workers in the presence of temporary jobs even though employment is lower. Indeed, temporary jobs, by decreasing the cost of unemployment, improve workers' outside option and thus their bargaining position. In table 2.4, I report the changes in the distribution of welfare measured in certainty equivalent consumption for the counterfactual economy, relative to the benchmark. I find that welfare decreases for all the groups of workers considered, between 1 and 1.5%.

Finally, I evaluate the effect of temporary jobs on the level of total output in the calibrated economy. Increasing ϕ_0 lowers output, which means that temporary jobs are associated with a *higher* level of production, even though employment decreases with ϕ_0. Figure 2.5 plots the relative change in output compared to the benchmark economy after increasing ϕ_0, and the change in employment and productivity. The figure indicates that high values of ϕ_0 are associated with an increase in employment but with a lower productivity. The latter effect dominates, resulting in losses in total output. As indicated in table 2.3, in the benchmark economy, in which temporary jobs are *not* regulated, productivity is 1.7% higher and total output is 0.7% higher than in the counterfactual economy with the 1980s regulation. In the presence of temporary jobs, the rate of separation is higher, because unproductive matches are more easily destroyed, and workers are more often reallocated from low to high productivity matches. In fact, the higher employment rate that is observed in the economy with tight restrictions on temporary jobs is associated with a misallocation of labor inputs which decreases productivity.

Figure 2.3 – Effect of hiring restrictions on temporary jobs : quarterly transition rates and unemployment (dashed : benchmark, dotted : counterfactual)

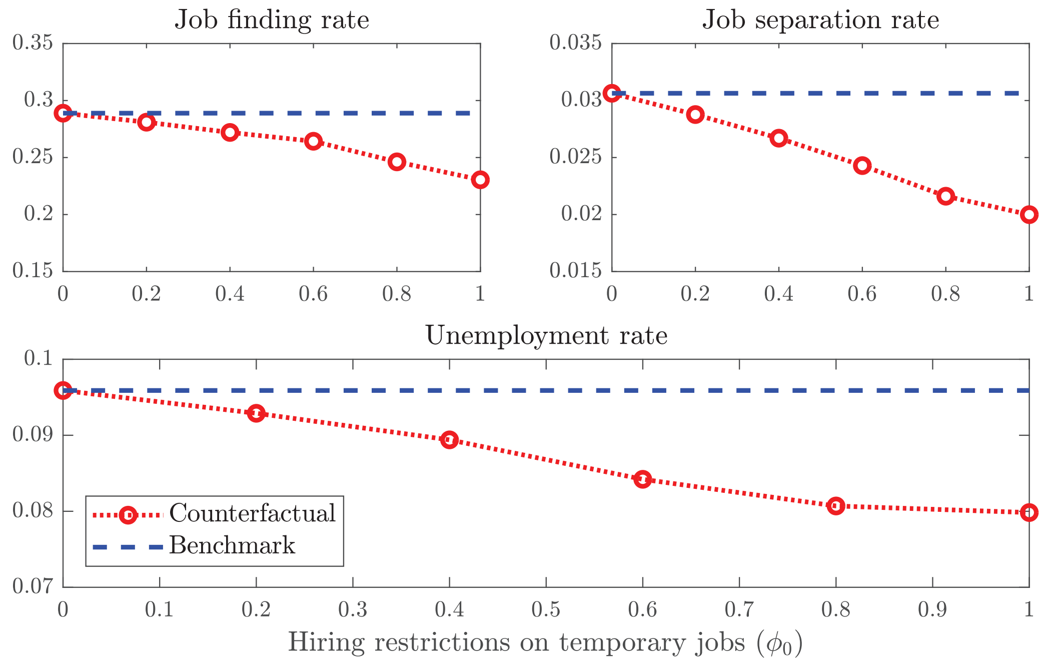


Figure 2.4 – Effect of hiring restrictions on temporary jobs : employment composition

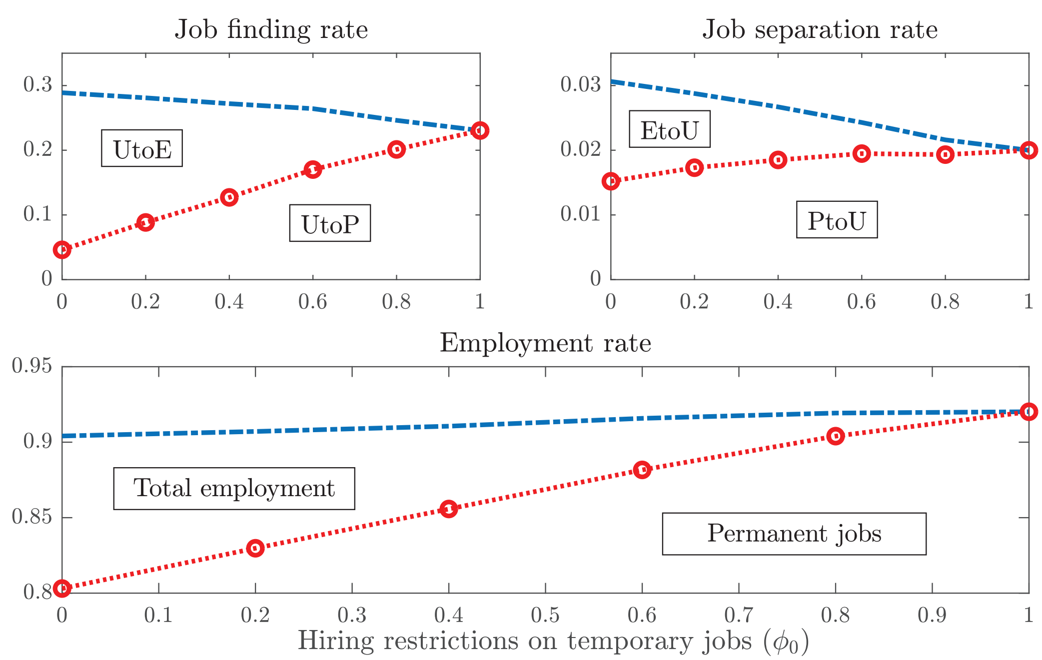
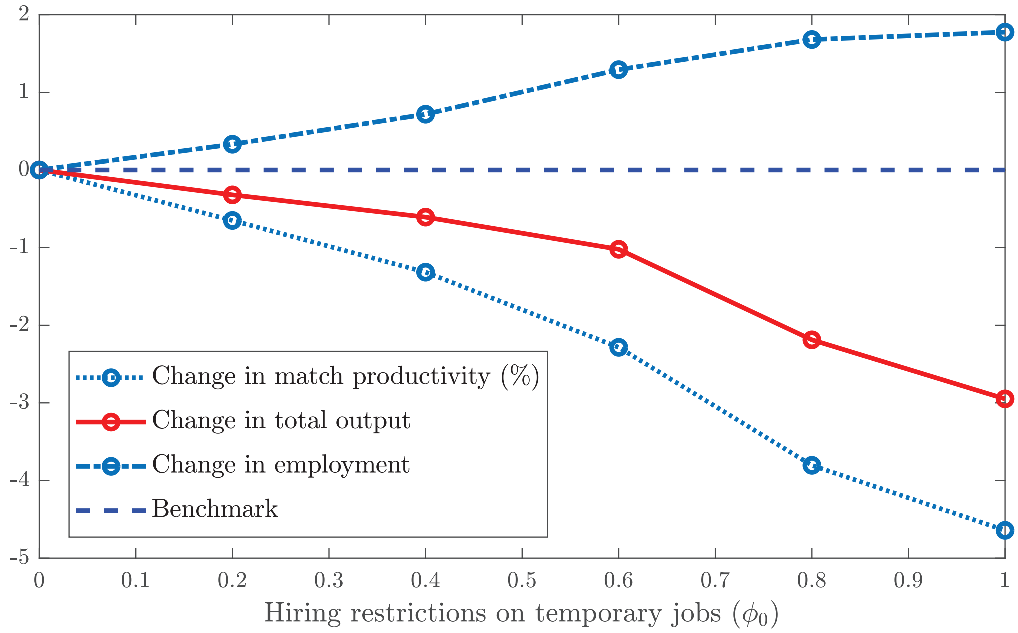


Figure 2.5 – Effect of hiring restrictions on temporary jobs : change in total output relative to benchmark economy (%)



Reducing firing costs

I examine now the effect of a reduction in the firing cost on labor market outcomes. I choose a set of values for the parameter F between zero (no firing cost) and $F = 2.5$, which corresponds to the benchmark economy, where it is equal to 3 months of output approximately. I present graphically the equilibrium outcomes associated with these counterfactual values (figure 3.7 and 3.8, in appendix 3.7.2), and I report in table 2.3 the results for the counterfactual economy without firing costs.

The quantitative results indicate that decreasing the firing costs tends to *increase* the unemployment rate and to *increase* productivity and output. The mechanisms are similar to what is observed in the experiment on the regulation of temporary jobs. Decreasing F increases both the job finding and the job separation rates, and results in net losses in employment. Moreover, decreasing the firing cost increases productivity and output despite the higher unemployment rate. In the economy without firing costs, the unemployment rate is one percentage point higher than in the benchmark economy, and total output is 0.74% higher. To sum up, the effect of reforms that introduce more flexibility in employment contracts is mixed. In our calibrated economy, reducing firing costs or relaxing restrictions on temporary jobs increase output but lower the employment rate.

However, it is interesting to note that decreasing the firing cost has consequences on welfare that are different to what is observed after the deregulation of temporary contracts. The results indicate that lowering the firing cost *decreases* welfare among employed workers (-0.45%). Strikingly, we also observe that welfare is very slightly lower even among the *unemployed workers* (-0.16%). Moreover, examining the changes in the distribution of welfare in the entire labor force (2.4) suggests that reducing the firing cost to zero lowers welfare among the entire labor force, even though the losses are more concentrated around the median (welfare is 1% lower for the worker with median consumption). These findings contradict the usual insiders-outsiders analysis, stating that a strict employment protection increases welfare among workers employed in permanent jobs at the expense of temporary and unemployed workers (e.g. Blanchard and Summers (1986), Lindbeck and Snower (2001)). This result comes from limited commitment, which might prevent efficient risk-sharing between the agents. The firing cost mitigates the commitment problem and thus can generate efficiency gains, even for matches formed between unemployed workers and employers.

Table 2.3 – Model outcomes : benchmark versus counterfactual economies

	Benchmark	Restrictions on TC	No firing costs
Parameter values			
Hiring restrictions on TC (ϕ_0)	0	0.43	0
Firing costs (F)	2.5	2.5	0
Labor market stocks (%)			
Employment share TC	11.2	5.5	0
Unemployment rate	9.6	8.7	10.6
Quarterly transition rates (%)			
UtoE	28.9	27.1	29.7
UtoP	4.6	13.4	29.7
EtoU	3.1	2.6	3.5
PtoU	1.5	1.8	3.5
Change relative to benchmark economy (%)			
Output	-	-0.75	0.74
Productivity	-	-1.75	1.93
Wages	-	-1.64	0.40
Change in welfare relative to benchmark (%)			
Employed workers	-	-1.2	-0.45
Unemployed workers	-	-1.45	-0.16

Table 2.4 – Change in distribution of welfare among workers relative to benchmark economy (%)

Percentile	p10	p25	p50	p75	p90
Restrictions on temporary contracts	-1.47	-1.58	-1.19	-1.50	-1.06
No firing costs	-0.25	-0.49	-1.00	-0.16	-0.60

2.4 Discussion

This section discusses the results about the effect of the employment protection on welfare and productivity.

The model indicates that firing costs tend to decrease productivity and that temporary contracts have the opposite effect. This suggests that policies aimed at introducing more flexibility in labor contracts are associated with higher productivity. This result comes from the fact that a tight employment protection generates adjustment costs which slow down the reallocation of labor across matches. This negative effect of employment protection has been discussed in the macroeconomic literature (e.g. Hopenhayn and Rogerson (1993), Roys (2016)). But it has been argued as well that firing costs interact with incentives to invest in firm-specific human capital (e.g. Wasmer (2006)). This suggests that productivity is affected by employment protection through two channels with opposite effects.[12] However, the model presented in this chapter focuses only on the first channel. Further work could analyze the effect of employment protection on output through these two channels, especially in presence of long-term contracts, which magnify the incentives to invest in specific human capital.[13]

The policy experiments indicate that firing costs *and* temporary contracts are associated with welfare gains. In fact, in this model, the combination of the two types of jobs increases the space of feasible contract, which raises the total surplus of matches and the employer willingness to pay for workers. Given that the surplus is shared by bargaining, this improves the worker's value of forming a match. The value of unemployment is positively affected as well, since this increase in the worker's value tends to improve the expected value of search. This result comes from the fact that there is no constraint on wage setting, which introduces a direct link between the total surplus and the worker's value. When the wage is constrained, the value of the worker is only affected by the type of job instead : conditional on the wage, this value depends on the probability of separation and, therefore, on the degree of job security provided by the contract. An interesting extension of the model could be to analyze the effect of employment protection in presence of a minimum wage, in order to analyze further the effect of labor market reforms on the distribution of welfare.

One should notice that the positive effect of firing cost on welfare that I find is due to the limited commitment friction. When firms have the ability to fully commit to the

12. Wasmer (2006) argues that strong employment protection incentivizes workers to invest in firm-specific rather than general skills. Assuming gains from specialization implies that investment in specific instead of general human capital tends to increase productivity. In equilibrium, this is not so obvious though, in part because general human capital tends to be more valuable in presence of worker turnover.

13. When commitment is limited, firing costs could act as a commitment device reducing the risk of investing in human capital, especially when this human capital has a large firm-specific component.

contract, the firing costs has an unambiguously negative impact on its profits. However, this does not fundamentally affect the main idea that I am trying to convey in these first two chapters. In the end, these chapters examine the decision of firms to provide or not job security for their workers, which is based on the trade-off between risk-sharing and job security emphasized in chapter 1. This trade-off still exists when the contract space is extended to allow firms to fully commit. In such a case, the degree of job security will be a continuous choice variable instead of being simply a function of the choice between the permanent and the temporary contract.[14]

2.5 Conclusion

This chapter presented a model of the labor market with workers and firms sorting endogenously into permanent jobs with high firing restrictions and temporary jobs. The quantitative application, calibrated to match the features of the French labor market, indicates that the reforms that have removed the hiring restrictions on temporary jobs in France since the 1980s have increased total output, at the expense of a higher unemployment rate. I also find that in the calibrated economy, the firing cost is associated with welfare gains among workers. Indeed, when commitment is limited, high firing restrictions lead to efficiency gains due to better risk-sharing among employers and workers.

14. In this context, the firing costs will not generate efficiency gains but it might instead shift part of the risk away from the worker, by incentivizing the employer to provide more job security.

Chapitre 3

Employment Protection and Life-Cycle Labor Market Outcomes

3.1 Introduction

In OECD countries, the incidence of unemployment and temporary jobs is high among the youngest workers. The employment share of temporary jobs is, on average, almost three times higher among workers aged 15 to 24 than prime age employees. This ratio goes up to four among European countries, and is particularly high in countries where regular jobs are subject to high firing costs. Moreover, among the youngest workers, the incidence of temporary employment has more than doubled since the early 1980s, as shown in figure 3.1. In 2016, nearly one in two young employee has a temporary contract. Interestingly, this trend is concomitant to the implementation of the various labor market reforms that have eased restrictions on temporary contracts in Europe during the same period (Boeri, 2011).

These basic facts suggest that the consequences of employment protection laws are likely to be differ across age groups. [1] This chapter proposes a model to evaluate the effect of these laws on labor market outcomes along workers' life cycle. Similarly to the first two chapters of the thesis, the model introduces search frictions, and it mimics the dual

1. Moreover, existing empirical work strongly indicates that strong firing restrictions tend to increase the exposure of youth and low education (for instance Kahn (2007)).

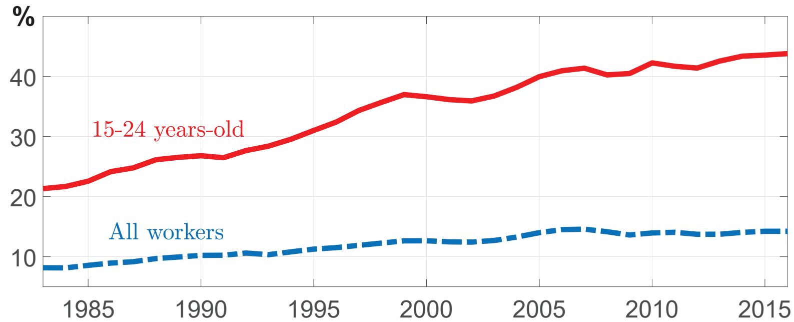


Figure 3.1 – The employment share of temporary jobs since the 1980s in the European Union (data source : OECD)

employment protection system that exists in several OECD countries. But in contrast to the model proposed in the previous chapters, in which the agents were homogeneous ex-ante, [2] I assume here that workers have heterogeneous skills prior to meeting with employers.

I assume that workers accumulate general human capital on-the-job. Moreover, I also assume that workers have heterogeneous innate ability which is gradually revealed publicly through Bayesian learning. These two channels lead to different outcomes across experience groups. I use the model to analyze how these outcomes are affected by firing costs in the case of France. I calibrate the model's parameters with the method of simulated moments, using a French labor force survey data. The model is calibrated for three different education groups : dropouts from secondary, secondary and tertiary education. I conduct a counterfactual for each for these groups, that consists in removing the firing costs. The result of this experiment indicates a negative effect on the employment rate, that is especially high among the youngest workers with low education. The firing costs decreases by 2% the probability of employment among dropout and secondary education workers.

An important aspect of the model is the presence of information frictions on the worker ability. Including this aspect in the model is primarily motivated by research arguing that information frictions plays an important in shaping mobility patterns (Jovanovic (1979), Papageorgiou (2014), Esteban-Pretel and Fujimoto (2014), Gervais et al. (2016), Gorry (2016)) and wage dynamics over the life cycle (Lange (2007), Kaymak (2012)). I

2. In the labor market model of chapter 2, the heterogeneity is entirely driven by the stochastic match quality that is drawn at the hiring stage and by the idiosyncratic productivity shocks that affect the match.

also follow the same idea as Pries and Rogerson (2005) and Faccini (2014), that analyze the negative effect of firing costs in an environment where the quality of matches in imperfectly observed. Indeed, information frictions generate extra-risk that increase the costs associated with employment protection. In particular, Faccini (2014) analyzes the effect of a dual employment protection system and concludes that temporary contracts improve labor market performance by acting as a screening device. However, this paper assumes that workers are homogeneous and that uncertainty is on match quality only. My model, in which the uncertainty about productivity depends on the worker's history, allows me to analyze further the effect of the legislation, by assessing its consequences for different experience groups.

Hence, this chapter combines elements from the literature analyzing life-cycle outcomes in frictional labor markets (Chéron et al. (2013), Bagger et al. (2014), Menzio et al. (2016)), with the literature that evaluates the effect of dual employment protection laws in search models (e.g. Cahuc and Postel-Vinay (2002), Blanchard and Landier (2002), Bentolila et al. (2012a), Cahuc et al. (2016a), Siassi et al. (2016)). It is also related to the literature analyzing the effect of labor market regulation on life-cycle outcomes, such as Gorry (2013), which analyze the effect of the minimum wage, and Chéron et al. (2011), analyzing the effect of firing costs. As opposed to Chéron et al. (2011), which examines the effect of employment protection across experience groups in a model with deterministic retirement age, this chapter focuses on the impact of the regulation for youth and prime age workers, in an environment with human capital accumulation and information frictions.

This chapter is organized as follows : section 2 describes the model. In section 3, I present the data and calibration procedure. Section 4 presents the results and I conclude in the last section.

3.2 The model

This section describes the model. In the following subsections I present the model economic and institutional environment, the value functions and the associated wages and transitions across unemployment, temporary and permanent jobs. Finally, I present the conditions associated with a steady state equilibrium.

3.2.1 Environment

Time is discrete. The economy is populated with a mass of risk neutral workers of size $L = 1$ and a mass of risk-neutral firms. Agents have a common discount factor β. At each period, a worker dies with probability ξ, upon which he is replaced by a newly born worker. Workers and jobs have heterogeneous *types*. The type of a worker is indexed by $i \in \{0,1\}$ and the type of a job is indexed by $j \in [0,1]$. The *quality of a match* between a worker of type $i \in \{0,1\}$ and a firm of type $j \in [0,1]$ is a function $x : \{0,1\} \times [0,1] \to \mathbb{R}$, denoted $x(i,j)$. When a worker enter in the labor market, he draws a type $i = 1$ with probability π^*. The type of a job, j, is discovered upon meeting between a worker and a firm, and is drawn from the cdf $G(j)$.

Workers accumulate human capital. The stock of human capital of a worker is given by k. I assume that there are M levels of human capital : $k \in \{k_1,...,k_M\}$, with $k_1 < .. < k_M$. A newly born worker enters in the labor market with human capital k_1, and accumulates HC on-the-job, through learning by doing. This accumulation process is stochastic : at a given time period, an employed worker with HC stock k_l acquires k_{l+1} with probability κ , for $1 \leq l < M$. I assume that human capital does not depreciate during unemployment. The productivity of a match is given by $y = f(x,k)$, and it increases with the quality of the match, x and with the stock of human capital k.

There are also information frictions in the labor market, that generate uncertainty about workers' types. When a worker enters in the labor market, his type is unknown to himself and to the other agents in the economy. However, when the worker is in a match and produces, his type is progressively revealed publicly through Bayesian learning. At each time period, the agents observe a normally distributed noisy signal of his true type $\iota = i + \epsilon$, with $\epsilon \sim N(0,\sigma^2)$. The signal is used to update the belief about the worker's type according to the rule

$$\pi' = \frac{\pi e^{-\frac{1}{2}\left(\frac{\iota-1}{\sigma}\right)^2}}{\pi e^{-\frac{1}{2}\left(\frac{\iota-1}{\sigma}\right)^2} + (1-\pi)e^{-\frac{1}{2}\left(\frac{\iota}{\sigma}\right)^2}} \tag{3.1}$$

where $\pi' = \Pr(i = 1|\pi, \iota)$ and π represent respectively the posterior and the prior belief that the worker has type $i = 1$.

The labor market is subject to search frictions. Unemployed workers searching for a job randomly meet firms looking to fill vacant positions. The mass of the population of unemployed workers is denoted n and the population of employed workers is $e = 1 - n$. Each period, an unemployed worker receives an income b. A firm can post a vacancy at each period at the cost c and then can be searching for an unemployed worker. The total mass of vacancies is given by v.

At each time period, the total number of contacts between firms and workers is given by the matching function $m(u, v)$. The matching function is increasing and concave in both arguments, satisfies homogeneity of degree one and displays constant returns to scale. A worker meets an employer with probability $p(\theta) \equiv m(u, v)/u = m(1, \theta)$ and an employer meets a worker with probability $q(\theta) \equiv m(u, v)/v = m(1/\theta, 1)$, where $\theta = v/u$ is the tightness of the market. Wages are determined by Nash Bargaining, and the worker has bargaining power $\gamma \in [0, 1]$.

As in the previous chapters, I introduce some of the main features of the employment protection legislation that prevail typically in a Continental European country. The agents can choose between a temporary (TC) and permanent contracts (PC). When a permanent job is destroyed the employer pays a firing cost f. This cost represents the administrative and procedural costs that are typically incurred by a layoff in these countries. The temporary job can be terminated at zero cost. However, the use of TC is restricted. Only a share ϕ_0 of new matches are allowed to sign a TC. The duration of temporary jobs is regulated. With probability ϕ, an ongoing TC must be converted into a PC or terminated. [3]

3. As opposed to the model presented in chapter 2, the workers are risk-averse and the agents do not sign long-term contracts. In the model of this chapter, there is no gain associated with the firing costs and the transitions towards permanent job are driven by the restrictions on temporary contracts, captured by the parameters ϕ_0 and ϕ. Hence, the objective of this chapter is to evaluate the sources, the distribution and to quantify the costs associated with employment protection, while the objective of chapter 2 were to analyze

3.2.2 Timing

In the labor market, an unemployed worker meets an employer looking to fill a vacancy with probability $p(\theta)$; an employer meets a worker with probability $q(\theta)$. Upon meeting, the type of the match is drawn from the cdf $G(j)$. With probability $1-\phi_0$, the match is not subject to the hiring restrictions on the TC and the agents can decide to sign a TC. Otherwise, they can only sign a PC. Based on the job type j, on the belief about the worker type and on the worker's stock of human capital and depending on being allowed to sign a TC or not, the agents decide between starting an employment relationship or staying unmatched. If the match is formed, the wage is determined by Nash Bargaining. In the case where the match is not formed, or in the absence of a meeting, the worker stays unemployed and his state is unchanged.

During an employment relationship, an exogenous separation occurs with probability δ. With probability $1-\delta$, the match continues and the worker's state evolves. The agents observe a new signal of the worker's type and the belief about his type are updated. With probability κ, the worker's stock of human capital increases from k_l to k_{l+1}. Based on the new worker's state, the agents decide to separate or to continue the match. In the case of continuation, the wage is renegotiated. In addition, when the worker and the firm are matched in a temporary job, the TC reaches its term with probability ϕ, and must be converted to a PC, unless it is terminated. Conditional on the surplus in a starting permanent job which is associated with the worker's state and with the job type, the agents decide to start a PC or to separate.

3.2.3 Value functions

Unemployment

The value function of an unemployed worker with belief π and human capital k is given by

---

its aggregate benefits and costs.

$$U(\pi,k) = b$$
$$+ \beta p(\theta) E_{j'} \left[(1-\phi_0) \max\Big(W_T(\pi,k,j'), W_P^0(\pi,k,j'), U(\pi,k) \Big) + \phi_0 \max\Big(W_P^0(\pi,k,j'), U(\pi,k) \Big) \right]$$
$$+ \beta (1 - p(\theta))\, U(\pi,k), \tag{3.2}$$

where $W_P^0(\pi,k,j)$ and $W_T(\pi,k,j)$ are the values of the worker in a starting permanent and a temporary job of type j. [4] The worker's expected value associated a meeting is formed over the distribution of job types that determines the match quality given belief π, and over the probability that the TC is not allowed. [5]

Vacancy

The value of holding a vacant job satisfies

$$V = -c +$$
$$+ \beta q(\theta) E_{\pi',k',j'} \left[(1-\phi_0) \max\Big(J_T(\pi',k',j), J_P^0(\pi',k',j'), V \Big) + \phi_0 \max\Big(J_P^0(\pi',k',j'), V \Big) \right]$$
$$+ \beta (1 - q(\theta))\, V, \tag{3.3}$$

in which $J_P^0(\pi,k,j)$ and $J_T(\pi,k,j)$ are the value functions of the employer in a starting permanent and temporary job, respectively. The expectation of a meeting with a worker is formed on the distribution of the job type and on the joint distribution of workers' states in the unemployment pool.

Permanent contract

In an ongoing permanent job of type j, the value functions of the worker with state (π,k) satisfies

4. The firing cost introduces a distinction between the surplus at the entry-level and the surplus for an ongoing match, because is affects differently the employer's outside option in both cases.

5. For notational convenience, I do not introduce explicitly the probability of retirement, ξ. It is understood that agents take into account this probability when discounting the next period value.

$$
\begin{aligned}
W_P^c(\pi,k,j) &= w_P^c(\pi,k,j) \\
&+ \beta(1-\delta)E_{\pi',k}\Big[\max\Big(W_P(\pi',k',j'),U(\pi,k')\Big)\,\Big|\,\pi,k\Big] + \beta\delta U(\pi,k),
\end{aligned} \tag{3.4}
$$

with $c = 0$ is the index for a starting match and $c = 1$ denotes an ongoing match. The value of the firm is

$$
J_P^c(\pi,k,j) = y(\pi,k,j) - w_P^c(\pi,k,j) + \beta(1-\delta)E_{\pi',k'}\Big[\max\Big(J_P(\pi',k',j),V-F\Big)\,\Big|\,\pi,k\Big] + \beta\delta V, \tag{3.5}
$$

where $w_P^c(\pi,k,j)$ and $y(\pi,k,j)$ are respectively the worker's wage and expected output of the match. In a permanent job, the worker's and the firm's expected values for the next period are formed over the density of the posterior belief of π and over the probability of an increase in the stock of human capital of the worker.

Temporary contract

The value of the worker in a temporary contract is given by

$$
\begin{aligned}
W_T(\pi,k,j) &= w_T(\pi,k,j) \\
&+ \beta(1-\delta)E_{\pi',k'}\Big[(1-\phi)\max\Big(W_T(\pi',k',j),U(\pi,k') + \phi\max\Big(W_P^0(\pi',k',j),U(\pi,k')\Big)\,\Big|\,\pi,k\Big] \\
&+ \beta\delta E_{\pi',k'}\Big[U(\pi',k')\,\Big|\,\pi,k\Big],
\end{aligned} \tag{3.6}
$$

where W_P^0 represents the value function of the worker in a starting permanent job. The employer's value in a temporary job solves

$$
\begin{aligned}
J_T(\pi,k,j) &= y(\pi,k,j) - w_T(\pi,k,j) \\
&+ \beta(1-\delta)E_{\pi',k'}\Big[(1-\phi)\max\Big(J_T(\pi',k',j),V) + \phi\max\Big(J_P^0(\pi',k',j),V\Big)\,\Big|\,\pi,k\Big] + \beta\delta V,
\end{aligned} \tag{3.7}
$$

The value functions in a temporary job are similar to those in a permanent job, except that the expected values for the subsequent period take into account the possibility that the TC ends.

3.2.4 Nash Bargaining and surplus functions

The wage is determined by Nash Bargaining. The surplus sharing condition for a temporary contract and for a starting permanent job satisfies

$$(1-\gamma)\,(W_T(\pi,k,j)-U(\pi,k)) = \gamma\,(J_T(\pi,k,j)-V) \tag{3.8}$$

$$(1-\gamma)\left(W_P^0(\pi,k,j)-U(\pi,k)\right) = \gamma\left(J_P^0(\pi,k,j)-V\right) \tag{3.9}$$

where γ is the bargaining power of the worker. For a ongoing permanent job, surplus sharing by Nash Bargaining implies

$$(1-\gamma)\left(W_P^1(\pi,k,j)-U(\pi,k)\right) = \gamma\left(J_P^1(\pi,k,j)-V+F\right) \tag{3.10}$$

In an ongoing PC, the firing cost deteriorates the firm's outside option and therefore it improves the worker's bargaining position. As a result, the wage will be lower in a starting PC than an ongoing PC conditional on the state (π,k,j).

Using the Nash Bargaining conditions (3.9) and (3.8), combined with the value functions (3.6), (3.4), (3.7) and (3.5) allows to write the total surplus in a temporary and a starting permanent job as

$$
\begin{aligned}
S_T(\pi,k,j) &= y(\pi,k,j) + \beta(1-\delta)E_{\pi',k'}\Big[(1-\phi)\max\Big(S_T(\pi',k',j),0\Big) + \phi\max\Big(S_P^0(\pi',k',j),0\Big)\Big|\,\pi,k\Big] \\
&\quad - \Big\{U(\pi,k,j) - \beta E_{\pi',k'}\Big[U(\pi,k',j)\Big|\pi,k\Big]\Big\} - (1-\beta)V \qquad (3.11) \\
S_P^0(\pi,k,j) &= y(\pi,k,j) + \beta(1-\delta)E_{\pi',k'}\Big[\max\Big(S_P^1(\pi',k',j)-F,0\Big)\Big|\,\pi,k\Big] \\
&\quad - \Big\{U(\pi,k,j) - \beta E_{\pi',k'}\Big[U(\pi,k',j)\Big|\pi,k\Big]\Big\} - (1-\beta)V \qquad (3.12)
\end{aligned}
$$

and the value of the surplus in an ongoing permanent job, obtained from the bargaining conditions (3.10), is given by

$$
\begin{aligned}
S_P^1(\pi,k,j) &= y(\pi,k,j) + \beta(1-\delta)E_{\pi',k'}\Big[\max\Big(S_P^1(\pi',k',j),0\Big)\Big|\,\pi,k\Big] \\
&\quad - \Big\{U(\pi,k,j) - \beta E_{\pi',k'}\Big[U(\pi,k',j)\Big|\pi,k\Big]\Big\} - (1-\beta)(V-F) \qquad (3.13)
\end{aligned}
$$

From these expressions for the surplus can be computed the policy functions associated with the hiring and separation decisions.

3.2.5 Wages

Wages can be computed using the expression for the surplus (3.12), (3.13) and (3.11), combined with the Nash Bargaining conditions (3.9), (3.10) and (3.8). The worker's surplus satisfies

$$
\begin{aligned}
W_P^c(\pi,k,j) - U &= \gamma S_P^c(\pi,k,j), \text{ for } c = 0,1 \\
W_T(\pi,k,j) - U &= \gamma S_T(\pi,k,j).
\end{aligned}
$$

The wage paid in each type of contract solve

$$w_P^c(\pi,k,j) = \underline{w}_P^c(\pi,k,j) + \gamma S_P^c(\pi,k,j) \tag{3.14}$$

$$w_T(\pi,k,j) = \underline{w}_T(\pi,k,j) + \gamma S_T(\pi,k,j), \tag{3.15}$$

with the reservation wage given by

$$\underline{w}_P^c(\pi,k,j) = \beta(1-\delta)\gamma E_{\pi',k'}\Big[\max\Big(S_P^1(\pi',k',j)\;\Big|\;\pi,k\Big] + \Big\{U(\pi,k,j) - \beta E_{\pi',k'}\Big[U(\pi,k',j)\Big|\pi,k\Big]\Big\}$$

$$\underline{w}_T(\pi,k,j) = \beta(1-\delta)\gamma E_{\pi',k'}\Big[(1-\phi)\max\Big(S_T(\pi',k',j),0\Big) + \phi\max\Big(S_P^0(\pi',k',j),0\Big)\Big|\;\pi,k\Big]$$
$$+ \Big\{U(\pi,k,j) - \beta E_{\pi',k'}\Big[U(\pi,k',j)\Big|\pi,k\Big]\Big\}.$$

3.2.6 Hiring, separation and labor market transitions

Hiring

In the absence of constraint on the contract choice, the worker is hired in a TC if the surplus (3.11) associated with a temporary job is positive.[6] If the match is not allowed to form a TC and can only sign a PC, the worker is hired under the condition that (3.12) is positive. The hiring decision depends on the worker states and on the job type. It is determined on the perceived quality of the match, that is a function of the worker state. Indeed, the belief on the quality of the match is formed on the type of job and on the belief on the worker type, π. The stock of human capital, by increasing the worker productivity also affects the hiring decision.[7] Conditional on the worker state, the probability of hiring on a PC is given by

6. In the absence of restrictions, the TC is always chosen because it generates a higher surplus in this framework.

7. The effect of human capital on the hiring decision is not clear : a high human capital increases output in the match but it tends also to increase the worker outside option, which makes him more picky in his choice of job type. Moreover, workers with low experience have high incentives to accept a job quickly in order to increase faster their stock of human capital.

$$h_P(\pi,k) = (1-\xi)\phi_0 \Pr\Big(S_P(\pi,k,j') \geq 0 \,\Big|\, \pi,k\Big), \tag{3.16}$$

and the probability of hiring on a TC is

$$h_T(\pi,k) = (1-\xi)(1-\phi_0)\Pr\Big(S_T(\pi,k,j') \geq 0 \,\Big|\, \pi,k\Big). \tag{3.17}$$

Note that since that the surplus in a temporary job is always greater than that of a PC, these probabilities satisfy $h_P(\pi,k) \leq h_T(\pi,k)$ for all (π,k).

Conversion into a permanent contract

When the temporary job ends, the TC should either be converted into a PC or be destroyed. The contract is converted if the surplus (3.12) is positive given the state of the match. The probability of conversion is

$$c(\pi,k,j) = (1-\xi)(1-\delta)\phi \Pr\Big(S_P^0(\pi',k',j) \geq 0 \mid \pi,k,j\Big). \tag{3.18}$$

Similarly to the decision to form a permanent contract at the hiring stage, the conversion happens only when the maximum duration of the temporary contract is reached, which occurs with probability ϕ.

Separation

In a permanent job, separations are driven by the evolution of the state of the worker. In a temporary job, separation decisions respond to evolution of the state but also to the conversion decision. Then, the probability of a separation to unemployment in a permanent job is

$$s_P(\pi,k,j) = (1-\xi)\Big[\delta + (1-\delta)\Pr\Big(S_P^1(\pi',k',j) < 0 \mid \pi,k,j\Big)\Big] \tag{3.19}$$

and the probability of a separation when the worker holds a TC is

$$s_T(\pi,k,j) = (1-\xi)\Big\{\delta + (1-\delta)\Big[(1-\phi)\Pr\Big(S_T(\pi',k',j) < 0 \mid \pi,k,j\Big) + \phi - c(\pi,k,j)\Big]\Big\}. \tag{3.20}$$

3.2.7 Steady state equilibrium

I solve a steady state equilibrium. The free entry condition holds and the value of a vacant job is zero. Thus, the tightness of the market satisfies :

$$\frac{c}{\beta q(\theta)} = (1-\gamma)E_{\pi',k',j'}\Big[(1-\phi_0)\max\Big(S_T(\pi',k',j), S_P^0(\pi',k',j'),0\Big) + \phi_0\max\Big(S_P^0(\pi',k',j'),0\Big)\Big], \tag{3.21}$$

where the expected value of a contact, given by the right hand side, is computed over the stationary distribution of (π',k') in the unemployment pool. Additionally, at the steady state equilibrium, the value functions (3.2) to (3.7) are satisfied ; the Nash bargaining conditions (3.9), (3.10) and (3.8) are met ; the transition probability functions satisfy (3.16) to (3.20) ; all flows are stationary.

3.3 Calibration

This section presents the data and calibration procedure.

3.3.1 Data

I use the French labor force survey dataset *Enquete emploi en continu*. This database is a rotating-panel of households with quarterly observations for workers aged 15 years-old and more. Households in the sample report labor market information of their members for at least one quarter for up to six consecutive quarters. In particular, the dataset contains information about wages, employment status, participation and importantly, about the type of employment contract. I define a temporary contract as fixed-term contracts (*contrats à durée déterminée*), work agency contracts (*contrats d'intérim*) or seasonal (*contrats saisonniers*). Using information about graduation dates, I compute labor market experience, defined as the time since entry in the labor market.

3.3.2 Calibration procedure

A subset of parameters is directly calibrated. The time period of the model is set to one month. The quarterly discount factor β is set to 0.995, in order to replicate a 4% interest rate per year. The probability of retirement/death of a worker is set to $\xi = 0.0024$ so that a career lasts 37.5 years in average. The workers' bargaining power, γ is equal to 0.4, as in Abowd and Allain (1996). The matching function is assumed to be Cobb-Douglas and the elasticity of matching function with respect to vacancy is set to $\eta = 0.7$, as estimated by Borowczyk-Martins et al. (2013) for the US. [8] Following Faccini (2014), the firing cost is chosen to be equal to 3 months of a mean match output. I introduce a trial period in the PC equal during which the worker can be dismissed at no cost. The trial period ends with probability ϕ_P ; I set $\phi_P = 0.181$ to match an expected duration of 6 months for the trial period. [9] The parameter ϕ is set to 0.043, to match an expected duration of 2 years for a TC. [10] Finally, the non-work utility b is normalized to one, and the starting value for human capital k_1 as well. The values of these parameters are reported in 3.1.

TABLE 3.1 – Parameters : external calibration

β	Discount factor	0.995	4 percent annual interest rate
ξ	Death probability	0.0024	37.5 year career average duration
γ	Worker barganing power	0.4	Abowd and Allain (1996)
η	Elasticity matching function	0.7	Borowczyk-Martins et al. (2013)
$F/E(y)$	Firing cost / mean match output	3	Faccini (2014)
ϕ_P	Probability end of trial period (PC)	0.181	Trial period duration : 6 months
ϕ	Probability end of TC	0.043	TC duration : 24 months
b	Non work utility	1	Normalization

8. For setting γ and η, I follow the same strategy as in Berson and Ferrari (2015)

9. Taking into account this trial period is important in order to avoid to over-estimate the importance of the TC as a screening device. Setting a mean value of 6 months is a conservative choice : according to the French law, the trial period is generally comprised between 4 and 6 months.

10. The maximum duration of a TC is generally comprised between 18 and 24 months in France.

Moreover, I assume that the output of a match is given by a CES production function in which the match quality and human capital enter as inputs, which yields the following functional form for expected output :

$$y(\pi,k,j) = (1-\pi)\Big[\alpha x(0,j)^{\rho} + (1-\alpha)k^{\rho}\Big]^{1/\rho} + \pi\Big[\alpha x(1,j)^{\rho} + (1-\alpha)k^{\rho}\Big]^{1/\rho}, \tag{3.22}$$

where α is the weight of the match quality in the production function compared to the human capital, and ρ governs the degree of complementarity between x and k. I also assume that the distribution of job types follows a Beta distribution with shape and location parameters A and B. Hence, it remains to calibrate the vector of the parameters that I mentioned above (α,ρ,A,B), jointly with the vector $(c,\delta,\sigma,\kappa,k_M,\phi_0,\pi^*)$ and the function describing the match quality, $x(i,j)$.

The calibration procedure for the match quality is the following. I calibrate the values of $x(i,j)$ for each worker type, i.e. for $i \in \{0,1\}$ and for the jobs of types $j=0$ and $j=1$, which represents the bounds of the support of j. This leaves me with 4 parameters, capturing the structure of comparative advantage of the workers in the jobs of types $j=0$ and $j=1$. Thereafter, the support for the job types is discretized and the values between $x(i,0)$ and $x(i,1)$ are obtained by linear interpolation. Hence, the jobs indexed by $j \in (0,1)$ can be considered as jobs in which tasks are a combination of the tasks embedded in jobs of type $j \in \{0,1\}$.

This leaves me with 15 parameters to calibrate. I use the simulated method of moments. I restrict the analysis to workers with at most 25 years of potential experience. [11] I divide the sample into three education groups : dropouts from secondary school, secondary and tertiary education groups. I also divide the sample into five experience cells, from 0 to 24 years of labor market years. For all three education groups, I compute the following

11. The model is primarily intended to match the wage and employment patterns of young and prime-age workers. Examining the labor market outcomes of older worker requires to introduce different mechanisms than those in the model. For instance, Chéron et al. (2013) emphasizes the important implications of the introduction of a deterministic retirement age for the behavior of high experience workers in a life-cycle search model. The model of this chapter follows a different approach, in which retirement is stochastic, and focuses mostly on the effect of human capital accumulation and information frictions.

empirical moments and their simulated counterpart :

- the employment share of temporary jobs, for the 4 age groups pooled together ;
- the quarterly transition from non-employment to employment (NE), and the transition rate from employment to non-employment (EN), for each experience groups ;
- the mean wage, for each experience groups, relative to the wage of the 0-4 experience group.

The first moment of interest is the employment share of temporary jobs. This moment allows to pin down a value for the parameter ϕ_0, which governs the transitions toward permanent and temporary contracts at the hiring stage, and, therefore, the composition of employment, conditional on the duration parameter ϕ. The experience-wage profile is intended to calibrate the parameters describing the accumulation of human capital, (κ, k_M). The transition rates between non-employment and employment are valuable to identify the parameters describing the structure of skills (the match quality term, the proportion of type 1 worker π^* and the parameters of the distribution of job type A and B) and the speed of learning, which is the speed at which the worker ability is revealed (which depends on the variance of the noise term, σ^2). Indeed, these moments capture the evolution of the job acceptance set along the life cycle and the rate at which workers are relocated across jobs as they gain experience. The match destruction probability δ is determined by the transition rate from employment to unemployment for high-experience workers, for whom information frictions play a minor role in the relocation process. Finally, the parameters of the CES match productivity function, ρ, α are calibrated jointly by the wage profile and by the transition rates.

Thus, for each of the three education groups, I obtain a vector of 15 empirical moments for 15 parameters to be calibrated. Using the model structure, I compute the simulated counterparts of these moments. I use a simulated annealing algorithm, which chooses the parameters minimizing the sum of the relative absolute difference between the empirical and the simulated moments. The minimization procedure requires to solve the model multiple times, in order to compare the simulated outcomes with the empirical moments for different parameter values. During this procedure, the model is solved in partial equilibrium : instead of calibrating the cost of vacancy posting c, I feed the objective function with the contact rate $p(\theta)$, and I recover the value of c that will be used thereafter to conduct the counterfactual experiments. The calibration results are presented in the following section.

3.4 Results

3.4.1 Calibration results

Parameter values

I report the values of the parameters in table 3.2. The results indicate a significant degree of heterogeneity among education groups. The higher the level of education, the higher the α parameter. This suggests that for highly skilled workers, the quality of matching is an important component of productivity. For lower education groups, the human capital has a high weight compared to the quality of the match. Therefore, for these groups, the cost of the mismatch can be offset by a high stock of human capital. In addition, for the dropout group, the production function has a higher degree of substitutability between x and k than other groups of workers. Furthermore, the calibration indicates that the learning process for the dropout group is faster than for the secondary and tertiary education group, as indicated by the values for the noise of the signal σ^2.[12]

12. Observe that the value of the parameter ϕ_0 is high compare to chapter 2. This comes from the fact that agents always prefer to sign temporary contract, because, as explained above, this chapter abstracts from risk-sharing considerations. Hence, a higher value of ϕ_0 is needed in this context to replicate the empirical share of temporary jobs.

Table 3.2 – Parameters : SMM

		Dropout	Secondary	Tertiary
$p(\theta)$	Contact rate	0.04	0.05	0.06
δ	Probability of exogenous separation	0.01	0.01	0.01
α	Share of match quality in match output	0.44	0.68	0.91
ρ	Complementarity bw HC and match quality	-1.15	-14.18	-7.31
σ^2	Variance of signal for worker ability	8.08	8.35	18.08
k_M	Higher possible value for human capital	1.57	1.56	2.95
κ	Probability acquisition higher HC	0.07	0.06	0.02
ϕ_0	Hiring restrictions on TC	0.63	0.40	0.54
Distribution of skills				
π^*	Proportion worker type 1	0.33	0.42	0.45
A	Shape of distribution of firm type	8.39	5.82	13.17
B	Location of distribution of firm type	0.49	18.51	19.16

Model fit do the data

In table 3.3, I report the targeted empirical moments along with their simulated counterparts. The calibrated model exhibits overall a good fit to targeted moments, especially for the dropout and the secondary education group. Qualitatively, the model reproduces the declining shape of the experience profile of labor market mobility (NE and EN transitions), and the increasing shape of the wage profile as well.

Table 3.3 – Simulated vs targeted moments : experience groups

		Dropout		Secondary		Tertiary	
	LM experience	Data	Model	Data	Model	Data	Model
N to E (quarterly)	0-4 years	0.176	0.119	0.261	0.135	0.290	0.162
	5-9	0.141	0.124	0.169	0.136	0.195	0.164
	10-14	0.115	0.120	0.141	0.130	0.156	0.156
	15-19	0.117	0.125	0.123	0.135	0.142	0.167
	20-24	0.106	0.117	0.127	0.128	0.111	0.153
E to N	0-4	0.122	0.088	0.090	0.082	0.053	0.070
	5-9	0.073	0.035	0.045	0.025	0.027	0.019
	10-14	0.047	0.039	0.029	0.028	0.021	0.020
	15-19	0.035	0.035	0.023	0.025	0.015	0.019
	20-24	0.027	0.036	0.021	0.025	0.015	0.019
Mean wage	0-4	1.000	1.000	1.000	1.000	1.000	1.000
	5-9	1.167	1.161	1.194	1.183	1.214	1.218
	10-14	1.230	1.247	1.284	1.299	1.388	1.400
	15-19	1.290	1.274	1.417	1.338	1.572	1.517
	20-24	1.349	1.282	1.509	1.348	1.683	1.583
Share of TC	All workers	0.153	0.132	0.150	0.160	0.112	0.096

Figure 3.2 displays the fit between the empirical and the simulated employment rate, conditional on labor market experience. The model fits closely the empirical employment rate, except for the very lowest experience groups. The model also reproduces well the mean wage conditional on experience, as shown in figure 3.3. [13]. As a validation exercise, I compare the simulated experience profile of the employment share of temporary job, with the corresponding empirical profile, which is not targeted. I obtain a close fit of this moment for the two highest education groups.

13. Note that in figure 3.3, the wage is normalized with respect to that in the zero-year experience group.

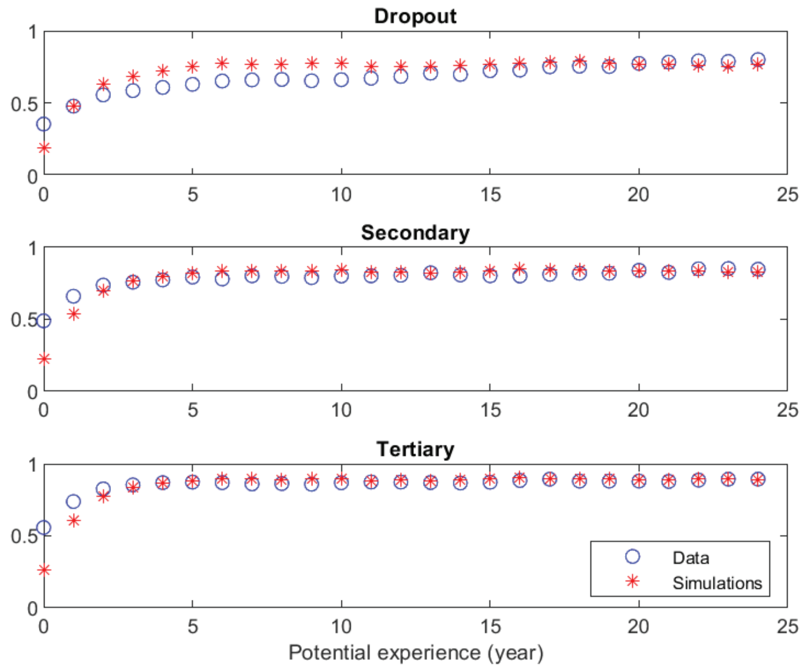


Figure 3.2 – Employment rate over the life cycle : data vs model (targeted)

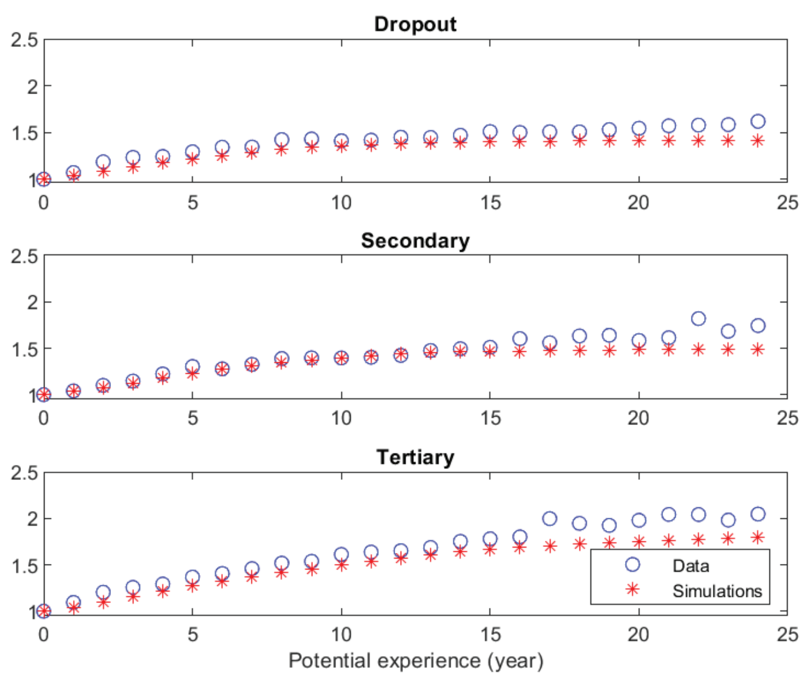


Figure 3.3 – Life cycle wage : data vs simulations (targeted)

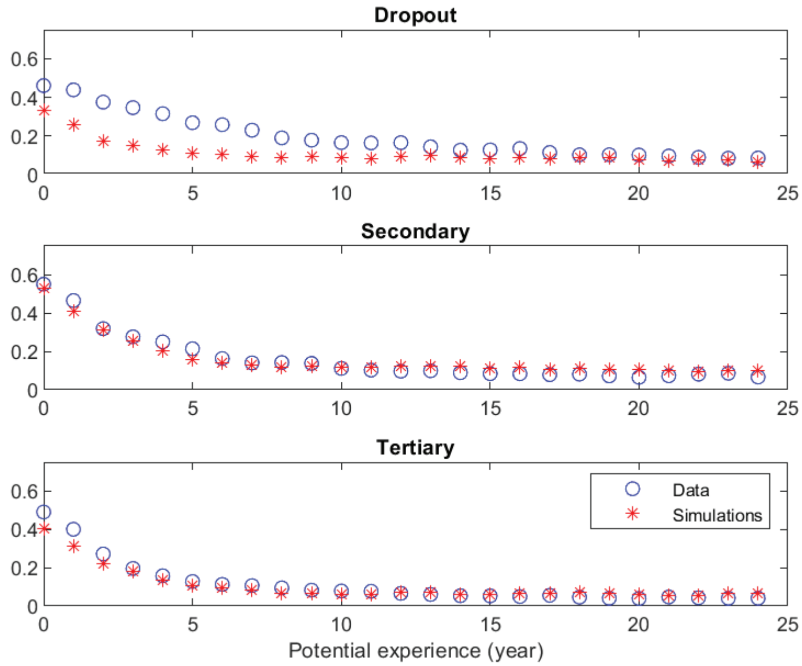


FIGURE 3.4 – Employment share temporary job : data vs simulations (non targeted)

3.4.2 The effect of firing costs on employment and wage

I use the calibrated model to evaluate quantitatively the effect of firing costs on life cycle employment and wages. My counterfactual consists in eliminating the firing costs by setting $F = 0$. I compute the model equilibrium under this alternative calibration and I run some simulations to compute the employment rate and the average wage for the different experience and education groups. The figures 3.5 and 3.6 report the relative difference between the outcome of the counterfactual and the benchmark simulations, for these different groups.

In figure 3.5, the blue line represents the relative difference between the counterfactual and the benchmark employment rate, conditional on experience. The experiment suggests that, overall, firing costs have a negative effect on employment. For the two lowest education groups, the employment rate is relatively *higher* in the counterfactual economy compare to the benchmark. The negative effect is concentrated on the low-experience and the low-education workers. For the group of dropout and secondary education workers with zero experience, the employment rate is almost 2% higher in the counterfactual

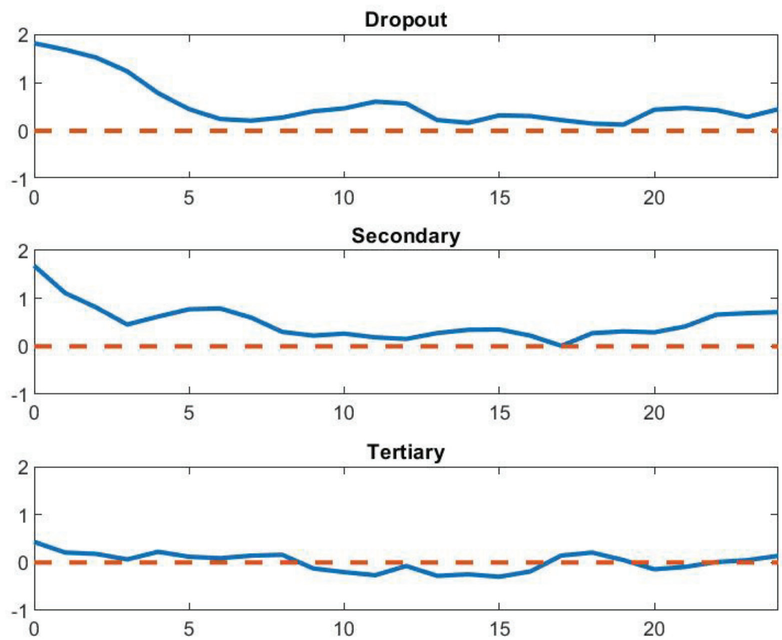


Figure 3.5 – The effect of firing costs over the life-cycle : relative difference between counterfactual and benchmark employment (%). (Solid line : counterfactual, no firing costs ; dotted : benchmark)

economy. However, this negative effect diminishes as the worker accumulates labor market experience : for prime-age workers, the negative effect is mild. For tertiary education workers, the effect of firing costs on employment is close ot zero.

The figure 3.6 reports the relative difference between the average wage in the counterfactual and the benchmark economies, for the different education and experience groups. The wage is negatively affected by the firing cost for all education groups. The effect is particularly strong among workers of the dropout group, and to a less extent, among those of the secondary education group. The negative effect on the wage is persistent over the life-cycle, as opposed to that on the employment probability.

I perform a decomposition to examine the mechanisms behind these results. I conduct a different set of experiments, in which I compare the benchmark and the counterfactual economy (with $F = 0$), by keeping constant the tightness of the market and, therefore, the probability of contact for a worker, $p(\theta)$. By doing so, I can evaluate the relative importance of partial equilibrium factors (human capital, information frictions,...), compare to the

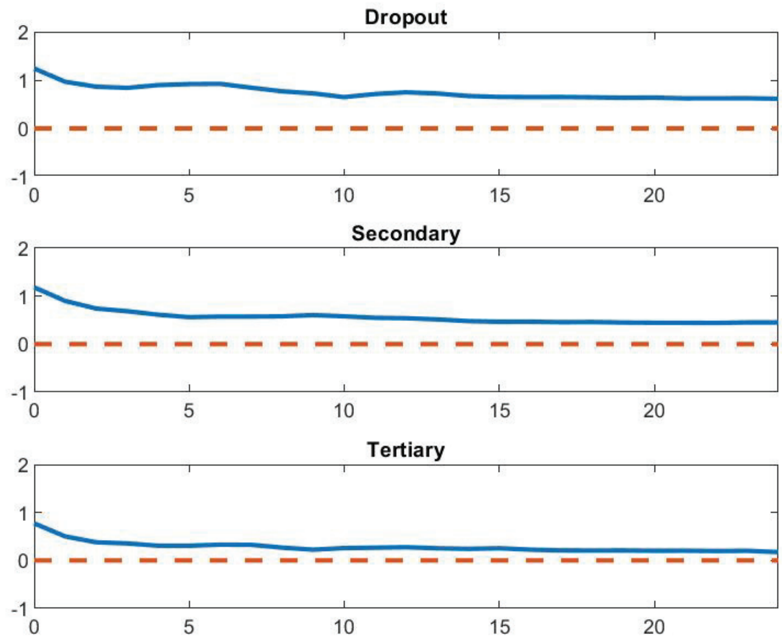


Figure 3.6 – The effect of firing costs over the life-cycle : relative difference between counterfactual and benchmark wage (%). (Solid line : counterfactual, no firing costs ; dotted : benchmark)

labor market equilibrium channel in explaining these results.

These exercises reveal that the partial equilibrium channels plays a negligible role in the negative effect of firing costs on employment. Indeed, when the tightness is kept constant, the economy with and without firing costs yield very similar employment patterns. This suggests that firing costs decrease employment mostly through the adjustment of labor market tightness, and that the dynamic of human capital and learning about skills do not affect substantially the transitions. Firing costs decrease firms' profits and the expected value of opening a vacant job. As a result, the mass of vacancy and the tightness decline. From the worker perspective, this decreases the contact and the job finding rates. Young workers are disproportionately affected by this decline in the tightness because they are overrepresented in the unemployment pool.

TABLE 3.4 – The labor market equilibrium effect of firing costs : relative difference between the benchmark and the economy with $F = 0$ (%).

	Dropout	Secondary	Tertiary
$p(\theta)$	2.01	2.25	0.46
EJ_0	4.74	5.33	1.5
N to E	1.60	2.19	0.46

The negative effect of firing costs is higher for low educated workers. As indicated in table 3.4, which compares the counterfactual and the benchmark economy, the tightness and the contact rate is more sensitive to a policy change in the market of the dropout and the secondary groups. In this table, I compute the relative difference in the expected profit of a firm, conditional on meeting a worker in the labor market, EJ_0, between the two economy. This reveals that the profits are much more affected by firing costs for firms matching with low educated workers than for those matching with tertiary educated workers. Through this channel, the tightness reacts differently in each sub-markets, which explains part of the heterogeneity of the effect of employment protection.

3.5 Conclusion

This paper builds a life-cycle equilibrium search model to analyze the effect of a dual employment protection legislation, characterized by the presence of permanent contracts subjects to high firing costs and temporary contracts. The model is calibrated on a French labor force survey dataset, using the simulated method of moments, for three different education groups. A counterfactual experiment indicates that firing costs increases the unemployment rate among workers with low education and low experience. A decomposition reveals that this is mostly explained by a change in the tightness of the market, due to the negative impact of firing costs on firms' profits.

The analysis has focused on the effect of employment protection on employment and wages. The model offers a structure which can be used to analyze the effect of employment protection on productivity. An interesting question could be to analyze how employment protection interacts with information and search frictions, and how it affects the sorting of heterogenous workers across different jobs.

Conclusion

This thesis analyzed the effect of employment protection on labor market outcomes. The two first chapters analyze the aggregate effect of firing costs and temporary contract, whereas the third chapter evaluates the effect of employment protection across different experience and age groups. The main objective of the first chapter is to understand how agents in the labor market choose between signing a temporary or a permanent contract. In this chapter, I analyze a dynamic contracting problem between a worker and a firm. By doing so, I emphasize a trade-off between risk-sharing and flexibility which drives the choice of contract. The second chapter proposes a model of the labor market which is based on the dynamic contracting problem of chapter 1, intended to analyze the effect of firing costs and temporary contracts. In this model, the sorting of agents into permanent and temporary jobs is endogenous to the risk-sharing problem presented in chapter 1. The quantitative results of chapter 2 indicate that temporary contracts have crowded-out permanent jobs in France, increased productivity and unemployment. Finally, the third chapter proposes a life-cycle model of the labor market with human capital accumulation and information frictions, which suggests that strong firing restrictions are detrimental to employment among low education and experience workers, but have a negligible effect on the employment rate of those with high education and experience.

Although the macroeconomic literature analyzing the effect of employment protection is rich, some interesting questions are still open. The empirical research in labor economics has provided evidence indicating that worker displacements are associated with large earning losses (e.g. Jacobson et al. (1993); Davis and von Wachter (2011)). Hence, there is probably a link between the employment protection legislation, income distribution and worker welfare, which has not been analyzed extensively yet. [14] Following this idea, two types of questions might be examined. The first type is related to the model presented in chapter 1. When firms have access to state-contingent contracts, how employment protection affects the design of risk-sharing arrangement between workers and firms ? How this shapes, in turn, the dynamic of earnings ? The second type of questions could be to analyze how firing costs affect firms' production and investment choices and to explore the consequences for the formation of idiosyncratic risk. Further research on this topic might provide additional insight for understanding the effects of employment protection on income risk and inequality, and for the design of policies combining labor market regulations and taxation tools.

14. The analysis of this link is not totally absent from the literature though : Cozzi and Fella (2016) found that severance payments are associated with substantial welfare gains in presence of large earning losses due job displacement.

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Appendix

3.6 Appendix of Chapter 1

3.6.1 Proof of proposition 1

Based on Thomas and Worrall (1988), I consider that the regularity conditions for the employer's maximization problem are met. I analyze the solution for the current wage and the set of values next period conditional on the separation rule. Thereafter, I discuss the layoff rule. I form the Lagrangian associated with z'. The first order condition for the current wage given promised value V and productivity z in the problem (1.2) satisfies :

$$-1 + \gamma u'(w(V,z)) = 0 \tag{3.23}$$

where γ is the multiplier associated with the promise-keeping constraint (1.3). For a given separation rule S, The first order condition associated with the choice of promised value $V(z')$, for $z' \notin S$ is given by

$$\left(1 + \frac{\overline{\kappa}(z')}{\beta}\right)\frac{\partial J(V(z'),z')}{\partial V(z')} + \gamma + \frac{\underline{\kappa}(z')}{\beta} = 0 \tag{3.24}$$

where $\underline{\kappa}(z')$ and $\overline{\kappa}(z')$ are the multipliers associated with the worker and the employer participation constraints, respectively. The envelope theorem yields

$$\frac{\partial J(V,z)}{\partial V} = -\gamma \tag{3.25}$$

Combining the first order conditions (3.23) and (3.24) with condition (3.25) for a given $z' \notin S$ yields the following equation which describes the relation between the current wage w and the wage at next period contingent on realization $z' \notin S$:

$$1/u'(w(V(z'),z')) = \frac{1/u'(w(V,z)) + \underline{\kappa}(z')/\beta}{1 + \overline{\kappa}(z')/\beta} \tag{3.26}$$

where $w(v(z'),z')$ is the wage contingent on state $(V(z'),z')$. If z' is such that no participation constraint is binding ($\underline{\kappa}(z') = \overline{\kappa}(z') = 0$), we have that $w(V(z'),z') = w(V,z)$, ie the wage in the state z' tomorrow is the same than the wage today. When only the employer's participation constraint is binding, ($\overline{\kappa}(z') > 0$, $\underline{\kappa}(z') = 0$), then the wage at state z' should be lower than the current wage in order to satisfy the participation constraint :

$$\begin{aligned} u'(w(V(z'),z')) &= \left[1 + \overline{\kappa}(z')/\beta\right] u'(w(V,z)) \\ &> u'(w(V,z)) \end{aligned}$$

Note also that in the case such that the worker's participation constraint is binding, the wage should be greater than the current wage. In our particular problem though, this will not happen because we assume that the worker's outside option (unemployment) is constant.

Layoff rule.

I denote by $\overline{V}_c(z')$ the value promised such that the employer participation constraint is binding in state z'. This value solves $g(\overline{V},z') = J(\overline{V}(z'),z') - F_c = 0$. Given that $J(V,z)$ is differentiable in z and V, and is strictly increasing in z and strictly decreasing in V, so $\overline{V}(z')$ is continuous and strictly in z'.

Separation occurs in states $z' \in S$ such that $\overline{V}_c(z') < U$, ie in states such that $J_c(U,z') <$

$-F_c$, in which the employer participation constraint and the worker participation constraint cannot be satisfied in the same time. Indeed, because of limited commitment, such a contract is unfeasible. Moreover, we have that in all states such that $J_c(U,z) > -F_c$, separation would be inefficient because it would leave the employer with a payoff lower than the value of continuation.[15] Then, separation occurs if and only if $\overline{V}(z') < U$. Given that $\overline{V}(z')$ is continuous and strictly increasing in z', and because the worker's outside option, U is independent of z', there is a unique cutoff value, $\underline{z}_P$, solving $\overline{V}_c(z') = U$, such that the match continues if $z' > \underline{z}$ and separation occurs otherwise.

Wage dynamics

I analyze the dynamics of the wage. According to the first order condition (3.23), the multiplier associated with the promised keeping constraint (1.3) should be positive, so the constraint is binding and the wage should be a continuous and strictly increasing function of the promised value V, given the properties of the instantaneous utility function. Denote by $\overline{w}(z') \equiv w(\overline{V}(z'), z')$ the wage associated with state $(\overline{V}(z'), z')$. Hence, using the condition (3.26), we have the wage next period given the wage today $w(V,z)$ satisfies

$$w(V(z'),z') = \mathbb{I}(\underline{w}(z') \geq w(V,z))\, w(V,z) + \mathbb{I}(\overline{w}(z') < w(V,z)\, \overline{w}(z'). \tag{3.27}$$

as stated in proposition 1. Now, I analyze the wage function and the reservation wage. Consider the recursive function $\tilde{V}(\tilde{w}, z)$, which I define as the lifetime value of the worker associated with the optimal contract that pays wage $\tilde{w}$ today when productivity is z. By construction, when $\tilde{w} = w(V,z)$ we have that $\tilde{V}(w(V,z),z) = V$, because $w(V,z)$ is the wage associated with optimal contract delivering value V when productivity is z. Using (3.27), the worker's value when the wage today is $\tilde{w}$ can be written as

15. In our environment, there is no point for the employer to commit ex-ante (before observing z') to an inefficient separation ex-post (after observing z'). In presence of different type friction (hidden effort for instance) though, the employer could, in theory, use the threat of a layoff to provide incentives to the worker and then writing a contract prescribing ex-post inefficient separation.

$$\tilde{V}(\tilde{w},z) = u(\tilde{w}) + \beta(1-\lambda)V(\tilde{w},z) \\ + \beta\lambda\int_{\underline{z}}^{z_h}\Big[\mathbb{I}(\tilde{w} \leq \overline{w}(z'))V(\tilde{w},z') + \mathbb{I}(\tilde{w} > \overline{w}(z'))\overline{V}(z')\Big]dG(z') + \beta\lambda G(\underline{z})U.$$

Because productivity shocks occurring with probability λ are iid, the expectation associated with a productivity shock only depends on the wage $\tilde{w}$ and not on z. Hence, the value function $\tilde{V}$ is a function of $\tilde{w}$ only and we can write

$$\begin{aligned}\tilde{V}(\tilde{w}) = u(\tilde{w}) + \beta(1-\lambda)V(\tilde{w}) + \beta\lambda\Big[\int_{\underline{z}}^{z_h}\mathbb{I}(\tilde{w} \leq \overline{w}(z'))dG(z')\Big]\tilde{V}(\tilde{w}) \\ + \Big[\int_{\underline{z}}^{z_h}\mathbb{I}(\tilde{w} > \overline{w}(z'))\overline{V}(z')\Big]dG(z') + \beta\lambda G(\underline{z})U \\ = u(\tilde{w}) + \beta\Big[1 - \lambda\,\mathrm{Pr}(\tilde{w} \leq \overline{w}(z'))\Big]\tilde{V}(\tilde{w},z) \\ + \beta\lambda\int_{\underline{z}}^{z_h}(\mathbb{I}(\tilde{w} > \overline{w}(z'))\overline{V}(z'))dG(z') + \beta\lambda G(\underline{z})U.\end{aligned}$$

Then, for $\tilde{w} = w(V,z)$, we have

$$V = u(w(V,z)) + \beta(1-\lambda)V + \beta\lambda\,\mathrm{Pr}(w(V,z) \leq \overline{w}(z'))V \\ + \beta\lambda\Big[\int_{\underline{z}}^{\tilde{z}}(\mathbb{I}(w(V,z) > \overline{w}(z'))\overline{V}(z')dG(z') + G(\underline{z})\,U\Big],$$

Now, define $\tilde{z}(V)$ as the realization of z' such that the employer constraint is binding after z' is realized, given value promised V, and that solves $\overline{V}(z') = V$. We have that $\tilde{z}(V) > \tilde{z}(U) = \underline{z}$. Hence the wage can be written as

$$w(V,z) = u^{-1}\left\{\Big[1-\beta[1-\lambda G(\tilde{z}(V))]\Big]V - \beta\lambda\int_{\underline{z}}^{\tilde{z}(V)} \overline{V}(z')dG(z') - \beta\lambda G(\underline{z})U\right\}$$
$$= w(V)$$

for all $z > \underline{z}$. Hence the assumption of iid shocks makes the wage independent of z. Using the fact that $\tilde{z}(U) = \underline{z}$, the reservation wage is written as

$$w(U) = u^{-1}\left\{\Big[1-\beta[1-\lambda G(\underline{z})]\Big]U - \beta\lambda G(\underline{z})U\right\}$$
$$= u^{-1}\left\{(1-\beta)U\right\},$$

independently of the contract type. □

3.6.2 Proof of lemma 1

As discussed in 3.6.1, I can define, for a given value promised V today a cutoff value in productivity tomorrow, z', denoted by $\tilde{z}(V)$ such that the employer's participation constraint solves with equality. This threshold solve $\overline{V}(z') = V$. For all $'z \leq \tilde{z}$, the employer constraint hence should be binding and the worker should receive the constrained wage $\overline{w}(z')$, as stated in appendix 1. Moreover, using that fact that lifetime utility is independent of z, as discussed in 3.6.1, this value should stay constant as long as the wage is unchanged, ie as long as $z' > \tilde{z}(V)$. Also, the value of the worker should be equal to $\overline{V}(z')$ when $z' \in [\underline{z}, \tilde{z}(V)]$ and the worker should obtain the value of unemployment upon separation, that occurs as soon as $z' < \underline{z}$. □

3.6.3 Proof of lemma 3

First, I will analyze how the probability of a separation changes with the firing cost. The employer value function can be written as

$$
\begin{aligned}
J_c(V,z) &= z - w_c(V) + \beta(1-\lambda)J_c(V,z) + \beta\lambda\left[\int_{\tilde{z}(V)}^{z_h} J(V,z')dG(z') + G(\tilde{z}(V))J(\overline{V}(\tilde{z}(V)),\tilde{z}(V))\right] \\
&= z - w_c(V) + \beta(1-\lambda)J_c(V,z) + \frac{\beta\lambda}{1-\beta(1-\lambda)}\int_{\tilde{z}(V)}^{z_h}\Big[1-G(z')\Big]dz' - \beta\lambda F_c
\end{aligned}
$$

where the second line follows from integration by part, using the facts that $\partial J_c(V,z) = \frac{1}{1-\beta(1-\lambda)}$ and that $J_c(\overline{V}(\tilde{z}(V)),\tilde{z}(V)) = -F_c$. Imposing the condition that $J(U,\underline{z}) = -F$ allows to write the threshold for separation as

$$
\underline{z} - w(U) + \frac{\beta\lambda}{1-\beta(1-\lambda)}\int_{\underline{z}}^{z_h}\Big[1-G(z')\Big]dz' + (1-\beta)F_c = 0 \tag{3.28}
$$

The derivative of $\underline{z}$ with respect to F_c satisfies :

$$
\begin{aligned}
\frac{\partial \underline{z}}{\partial F} &= -\frac{(1-\beta)(1-\beta(1-\lambda))}{1-\beta(1-\lambda G(\underline{z}))} \\
&< 0.
\end{aligned}
$$

Hence, we have that $\underline{z}_P < \underline{z}_T$, that makes the probability of separation lower in the permanent contract.

Now, analyze the probability of a wage cut, conditional on a wage $\tilde{w}$. Analyze the function $\tilde{J}(\tilde{w},z)$, that I define as the profits associated with the optimal contract paying wage $\tilde{w}$ and productivity z. Moreover, I will use again the function $\tilde{V}(\tilde{w})$, as in appendix 3.6.1, that represents the worker's value in a contract delivering wage $\tilde{w}$. Given the wage $\tilde{w}$, this function can be written as

$$
\tilde{J}(\tilde{w},z) = z - \tilde{w} + \beta(1-\lambda)\tilde{J}(\tilde{w},z) + \frac{\beta\lambda}{1-\beta(1-\lambda)}\int_{\tilde{z}(\tilde{V}(\tilde{w}))}^{\overline{z}_h}\Big[1-G(z')\Big]dz' - \beta\lambda F_c
$$

where $\tilde{z}(\tilde{V}(\tilde{w}))$ is the threshold for wage cut in the contract with wage $\tilde{w}$, that deliver value

$\tilde{V}(\tilde{w})$. For ease of notation, I simply define $h(\tilde{w}) \equiv \tilde{z}(\tilde{V}(\tilde{w}))$. This threshold solves

$$h(\tilde{w}) - \tilde{w} + \frac{\beta\lambda}{1-\beta(1-\lambda)} \int_{h(\tilde{w})}^{z_h} \left[1 - G(z')\right] dz' + (1-\beta) F_c = 0$$

and his derivative with respect to F satisfies $\frac{\partial h(\tilde{w})}{\partial F} = -\frac{(1-\beta)(1-\beta(1-\lambda))}{1-\beta(1-\lambda G(\underline{z}))} < 0$. Hence, conditional on the wage, the probability of wage cut **decreases** with F. In a contract paying wage $\tilde{w}$, the probability that the employer's constraint is binding at next period and the probability of a wage cut decreases with F. Hence wage cuts are less frequent in a PC than in a TC paying the same wage.

But the fact that wage cuts are less frequent in the PC **conditional on the wage** does not necessarily implies that wage cuts are less frequent **conditional on value promised**, as stated in lemma 3. The latter statement will be true if the wage in the TC is greater or equal than the wage paid in the PC, for a given value promised. This is indeed the case, because the value of a worker receiving wage $\tilde{w}$ in a PC, $\tilde{V}_P(\tilde{w})$ should be greater than the value of a worker receiving the same wage in a TC, in which the probability of a loss in income due to a wage cut or a separation is higher. That implies that for a given value promised, the wage should be higher in the TC. Hence, conditional on V, the probability of wage cut is higher in the TC. $\square$

3.6.4 Proof of lemma 4

The proof for this lemma follows from the proof in appendix 3.6.3, that argues that the wage should be higher in the TC for V given. Below is an alternative proof, which is a bit more formal.

Using the promise keeping constraint (1.3), I compute $u(w_T) - u(w_p)$, the difference between the instantaneous utility values of the worker in a temporary and a permanent contract. We know from the section above (appendix 3), that $\tilde{z}_T(V) > \tilde{z}_P(V)$ and that $\underline{z}_T > \underline{z}_P$ when $F_P > 0$ and $F_T = 0$. Moreover, we have that $\tilde{z}_P(V) \geq \underline{z}_P$ and that $\tilde{z}_T(V) \geq \underline{z}_T$. However, we don't know how $\underline{z}_P$ and $\tilde{z}_T(V)$ compare.

The difference in the instantaneous utility values can be expressed as

$$u(w_T) - u(w_P) = \int_{\tilde{z}_P(V)}^{\tilde{z}_T(V)} \Big(V - \overline{V}_T(z')\Big) dG(z') + \int_{\underline{z}_T}^{\tilde{z}_P(V)} \Big(\overline{V}_P(z') - \overline{V}_T(z')\Big) dG(z') + \int_{\underline{z}_P}^{\underline{z}_T} \Big(\overline{V}_P(z') - U\Big) dG(z') \tag{3.29}$$

if $\tilde{z}_T(V) \geq \underline{z}_P$, and

$$u(w_T) - u(w_P) = \int_{\underline{z}_T}^{\tilde{z}_T(V)} \Big(V - \overline{V}_T(z')\Big) dG(z') + \int_{\tilde{z}_P(V)}^{\underline{z}_T} \Big(V - U\Big) dG(z') + \int_{\underline{z}_P}^{\tilde{z}_P(V)} \Big(\overline{V}_P(z') - U\Big) dG(z') \tag{3.30}$$

if $\tilde{z}_T(V) < \underline{z}_P$. Since from lemma 1 and 3, we have that $V \geq \overline{V}_P(z') \geq \overline{V}_T(z') \geq U$, this implies that $u(w_T(V)) - u(w_P(V)) > 0$, ie that utility today needs to be higher in the temporary contract to make the worker indifferent with a permanent contract. Hence, we should have $w_T(V) > w_P(V)$. □

3.6.5 Proof of proposition 2

Compute the difference between the profits in a PC and a TC given V, $J_P(V,z) - J_T(V,z) \equiv \Delta J(V,z)$. We obtain the recursive function :

$$\begin{aligned}
\Delta J(V,z) &= u(w_P(V)) - u(w_T(V)) + \beta(1-\lambda)\Delta J(V,z) \\
&+ \beta\lambda \Big\{ \int_{\tilde{z}_P(V)}^{z_h} J_P(V,z') dG(z') - \int_{\tilde{z}_T(V)}^{z_h} J_T(V,z') dG(z') - G(\tilde{z}_P(V)) F \Big\} \\
&= u(w_T(V)) - u(w_P(V)) + \beta(1-\lambda)\Delta J(V,z) \\
&+ \beta\lambda \Big\{ \int_{\tilde{z}_T(V)}^{z_h} \Delta J(V,z') dG(z') + \int_{\tilde{z}_P(V)}^{\tilde{z}_T(V)} J_P(V,z') dG(z') - G(\tilde{z}_P(V)) F \Big\}.
\end{aligned}$$

The function $\Delta J(V,z)$, evaluated at $V = U$ is equal to

$$\Delta J(U,z) = \beta(1-\lambda)\Delta J(U,z) + \beta\lambda\left\{\int_{\underline{z}_T}^{z_h}\Delta J(U,z')dG(z') + \int_{\underline{z}_P}^{\underline{z}_T} J_P(V,z')dG(z') - G(\underline{z}_P)F\right\} \tag{3.31}$$

following that $\underline{z}_P = \tilde{z}(V)^P$ and that the reservation wage is the same across contracts, ie $w_P(U) = w_T(U) = u^{-1}\Big\{(1-\beta)\,U\Big\}$.

Now I analyze the sign of expression (3.31). Prior to doing that, I define $\hat{z}$ as the value of z such that $J_P(U,z) = 0$. Note that using integration by part, the employer's profit in the permanent contract can be written as

$$J_P(U,z) = z - w(U) + \beta(1-\lambda)J_P(U,z) + \frac{\beta\lambda}{1-\beta(1-\lambda)}\left\{\int_{\hat{z}}^{z_h}(1-G(z'))dz' - \int_{\underline{z}^P}^{\hat{z}} G(z')dz'\right\}.$$

Hence, the threshold $\hat{z}$ is given by

$$0 = \hat{z} - w(U) + \frac{\beta\lambda}{1-\beta(1-\lambda)}\left\{\int_{\hat{z}}^{z_h}(1-G(z'))dz' - \int_{\underline{z}^P}^{\hat{z}} G(z')dz'\right\},$$

with derivative with respect to F given by $\partial\tilde{z}/\partial F = -(\partial\underline{z}_P/\partial F)(\beta\lambda)/(1-\beta)$, which is positive since we know that the separation threshold decreases with F. As a result, we have that $\hat{z} \geq \underline{z}^T$ with $\hat{z} = \underline{z}^T$ for $F = 0$. Thus, because the employer's profits increases with z, we have $J_P(U,z_T) \leq J_P(U,\tilde{z}) = 0$. Hence, we have that $J_P(z',U) < 0$ for all $z' < \underline{z}^T$. Therefore, by rewriting expression (3.31), we obtain

$$\begin{aligned}\Delta J(U,z') = {}& \beta(1-\lambda)\Delta J(U,z) + \\ & \beta\lambda\left\{\int_{\tilde{z}}^{z_h}\Delta J(U,z')dG(z') - \int_{\underline{z}_T}^{\tilde{z}} J_T(U,z')dG(z') + \int_{\underline{z}_P}^{\hat{z}} J_P(U,z')dG(z') - G(\underline{z}_P)F\right\}\end{aligned}$$

which is negative because $J_T(U,z') > 0$ for all $z' > \underline{z}_T$ and because $J_P(U,z') < 0$ for all

$z' \in [\underline{z}_P, \hat{z}]$.

Now, analyze the derivative of function $\Delta J(V,z)$ with respect to value promised V. Combining the envelope condition (3.25) with the FOC (3.23) yields

$$\begin{aligned}\frac{\partial(\Delta J(V,z))}{\partial V} &= \frac{\partial J_T(V,z)}{\partial V} - \frac{\partial J_P(V,z)}{\partial V} \\ &= -\left\{\frac{1}{u'(w_P(V))} - \frac{1}{u'(w_T(V))}\right\}.\end{aligned}$$

We know from lemma 4 that $w_T(V) > w_P(V)$ for all $V > U$. Therefore, decreasing marginal utility implies that the derivative of $\Delta J(V)$ with respect to V is strictly decreasing with V. Hence there is unique value $\hat{V} > U$ such that $\Delta J(V,z) \geq 0$, or equivalently, such that $J_P(V,z) \geq J_T(V,z)$ for all $V \geq \hat{V}$. □

3.7 Appendix of Chapter 2

3.7.1 Proof of proposition 6

When the employer is only allowed to propose a permanent contract, the match is formed under the condition that $J_p(\tilde{V}_p, x, z_K) \geq 0$. Hence, the threshold for hiring in this case, x_P, solves $J_p(\tilde{V}_p(x), x_p, z_k) = 0$. When the employer is allowed to choose between both types of contracts, a PC is formed when $\Delta J(\tilde{V}(x), x, z_k) \geq 0$, which is increasing with x. Therefore, there is a cutoff in x, $\hat{x}$, such that the employer prefers a PC when $x > \hat{x}$ and a TC otherwise. Moreover, for $x \in [x_s^T, x_s^P)$, the TC is preferred, as discussed in lemma 5. Since $x_s^P \leq \hat{x}$, that implies that the cutoff for the formation of a TC, x_T, should be lower than x_P and $\hat{x}$. $\square$

3.7.2 The effect of firing costs on unemployment

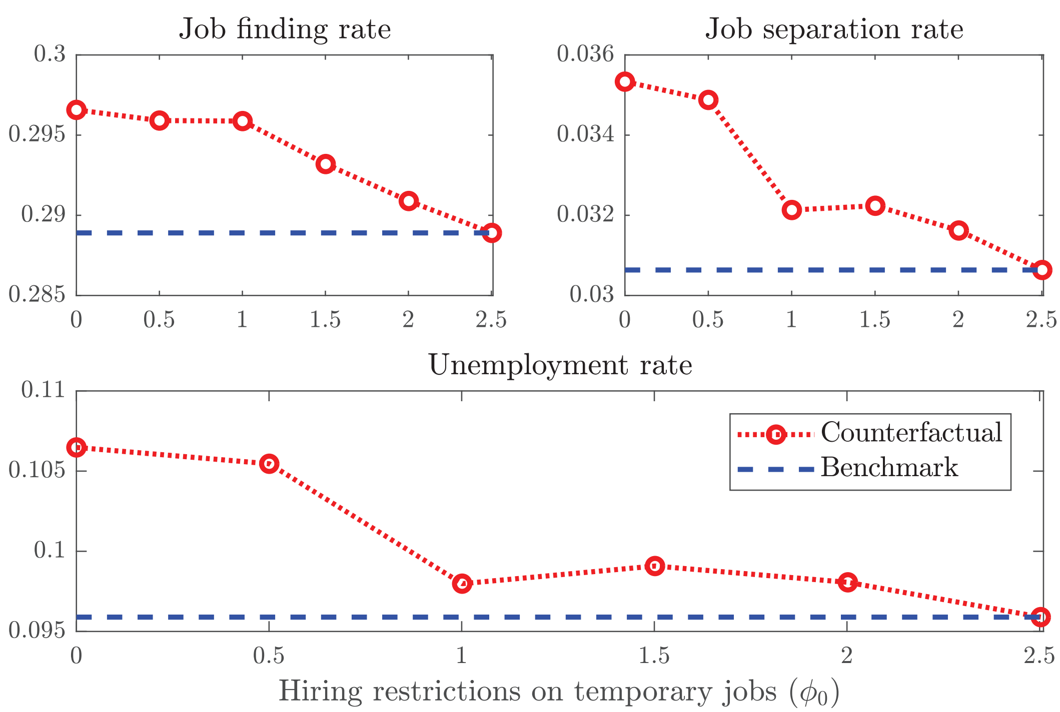

Figure 3.7 – Effect of a reduction in firing cost : quarterly transition rates and unemployment

3.7.3 The effect of firing costs on aggregate output

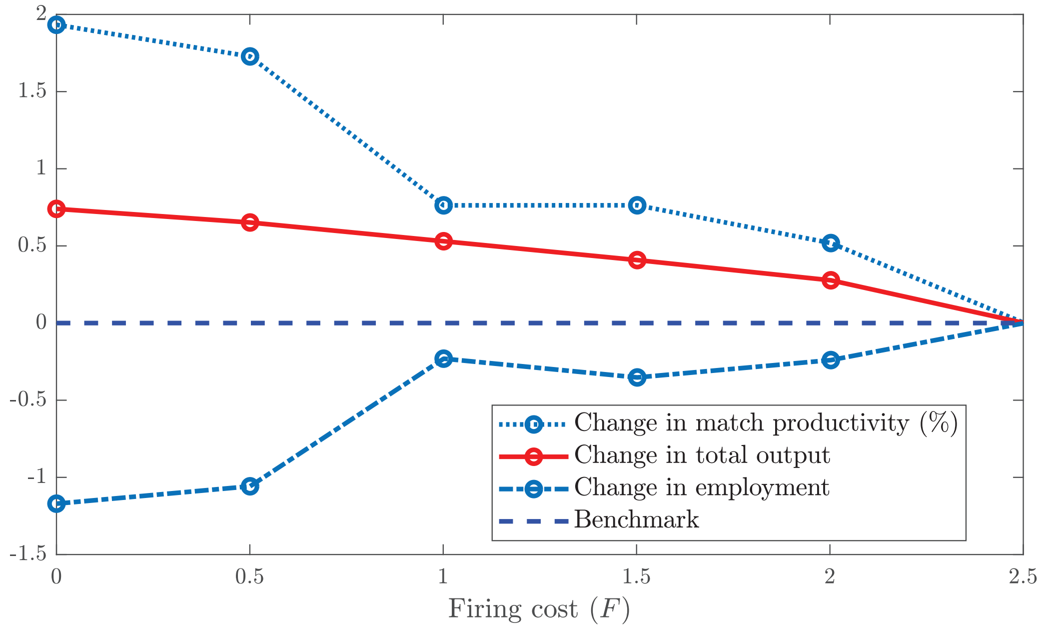

Figure 3.8 – Effect of a reduction in firing cost : change in output relative to benchmark (%)